THE ENGINEER

# A Seven-Day Journal

## Councils on Productivity

The Anglo-American Council on Productivity, originally set up in July, 1948, has resolved that, as the period of Marshall Aid, originally envisaged as the term of its activities, is coming to an end, and as the team programme is nearing completion, there is no need for the continued existence of a joint organisation. The Council as such and the U.S. Section of the Council will therefore end their existence on June 30th next. The work of publishing the remainder of the team reports and of following up both those and the ones already published is entirely a British responsibility. The U.K. Section of the Council will therefore continue in existence for the time being for this purpose. The three organisations comprising the U.K. Section—the Federation of British Industries, the British Employers' Confederation and the Trades Union Congress—have furthermore decided to continue their co-operative work in another way. They have accordingly decided to establish jointly a British Productivity Council. The new Council will seek to engage the active interest of individual industries in this field and to give them all possible help in their independent activities. The Council will also carry on educational work of its own. The following up of the work of the A.A.C.P. teams, the sponsoring of conferences and meetings of various kinds, the publication of literature and encouragement of the use of films are among the kinds of development foreseen. The intention is that the Council will consist of about twenty-four members, and will include representatives of many individual industries appointed by the British Employers' Confederation, the Federation of British Industries and the Trades Union Congress, and it is proposed to invite the nationalised industries to participate in it. Government representatives will not, however, be included.

## The Institution of Engineers-in-Charge

The forty-seventh annual dinner of the Institution of Engineers-in-Charge was held last Friday evening at the Holborn Restaurant, and was a function at which, as usual, a large company of members and their guests assembled. The president of the Institution, Mr. Robert Chalmers, M.I.C.E., was in the chair, and after the loyal toasts had been honoured "The Institution" was proposed by Mr. W. Robson Brown, M.P., A.M.I.Mech.E. In the course of a particularly arresting speech, Mr. Robson Brown said that the record of the Institution of Engineers-in-Charge was clear and precise, especially concerning its work in local government. Furthermore, he declared, the record of the engineers of this country was without parallel in the world, for, it was his conviction that British engineering achievements were greater than those of any other country. It was engineers, Mr. Robson Brown asserted, who now could carry this country through all its industrial and economic problems, and they should be ever watchful of the integrity of their profession. After commenting that the modern world revolved around the engineer, Mr. Robson Brown went on to express the view that the output of our factories was still too low. What was required, he suggested, was a genius who could inject into the mind of the working man the fact that there was an economic crisis, for, he concluded, it was a matter of grave concern that so many still did not realise our parlous economic state. The president, in acknowledging the toast, spoke of the work of the Institution. Through that work, he said, members were enabled to gain some comprehension of the community they endeavoured to serve. The toast "Our Guests and Friends" was next proposed by Mr. R. L. Quertier, M.I.Mech.E., vice-president, and drew a witty and gracious response from Dr. Andrew Topping, Dean of the London School of Hygiene and Tropical Medicine. The last toast on the programme was "Our President," proposed by Mr. F. E. Shaw, chairman of the Institution. It was accorded enthusiastically. After a brief acknowledgment by Mr. Chalmers, a successful evening was rounded off by an excellent entertainment.

## Royal Research Ship "Discovery II"

The Royal research ship "Discovery II," which has been undergoing a refit at Plymouth since returning from the Antarctic in December of last year, is expected to be ready for sea by May 15th. After recommissioning, the ship will be based at Plymouth and will work in the Atlantic taking measurements designed to improve our knowledge of the basic processes by which energy is transferred from the atmosphere to the ocean, and to promote a better understanding of the variations in ocean currents and other water movements. During the first cruise, of about a month's duration, the observations taken will relate mainly to the growth and decay of waves. Modern methods of physical research are opening up a new field of investigation and the results may be of practical value to shipping and coastal engineers. One of the objects of the first voyage is to improve the methods of recording waves from a ship and experiments will be made, using wave recorders fitted in the ship's side below the water line. To overcome the difficulty of the moving ship the records of pressure variations at two points in opposite sides will be combined with their vertical movements. The latest pattern of wave analyser will be carried to resolve a complex wave record into its component wave trains, and wind drifts will be measured by towing electrodes behind the ship and estimating the drift of electrodes and ship, at right angles to the course, from the small electromotive forces produced by the drift of the sea water and the wire connecting the electrodes through the earth's magnetic field. Another important aim is the study of physical, chemical and biological processes, which make one part of the ocean more productive than another, with particular interest in the regeneration of nutrient substances from the decay of small drifting marine plants and animals.

## Summer Meeting of the Institution of Water Engineers

The fifty-seventh summer general meeting of the Institution of Water Engineers is being held in Leeds and Harrogate this week, from Wednesday, May 14th, until to-day, Friday, 16th. The proceedings include visits to the Leeds Corporation waterworks and to the Digley reservoir of Huddersfield Corporation waterworks, a reception, and the presentation of a number of technical papers. The presidential address of the new president, Mr. K. L. Forster, M.I.C.E., was delivered on Wednesday. Mr. Forster commented on the problems and progress of the Institution and of the water industry generally. He said that one of the major difficulties since the war was the problem of recruiting suitable entrants, not merely engineering pupils, but also officials. A fruitful field abroad with which the Institution was concerned, was the activity of the International Water Supply Association; Mr. Forster recalled that this body was formed in 1947, and held its first congress at Amsterdam in 1949. He hoped that the second congress, to be held in Paris in June, would be even more successful than the first. Mr. Forster also prepared for the meeting a paper outlining the history of the Leeds Corporation waterworks. A paper entitled "The Covering of Two Service Reservoirs with Barrel Vault Roofs" was presented by C. A. Serpell, and a paper on "An Inverted Siphon for the Assabet River Crossing of the Wachusett Aqueduct" was contributed by Mr. S. M. Dore, of the Allegheny County Sanitary Authority, Pittsburgh, Pa., under a scheme for the exchange of papers. A paper on "Some Observations on the Correlation of Chemical and Biological Sequences at the Waterworks at Leeds" was presented by Professor E. A. Spaul.

## The Institution of Locomotive Engineers' President

The Institution of Locomotive Engineers has elected as its president Mr. C. M. Cock, the general manager of the traction department of the English Electric Company, Ltd., and a director of English Electric Export and Trading Company, Ltd. Mr. Cock, who has had a distinguished career in the railway and engineering world, both in this country and abroad, was born in Melbourne, Australia, and received his early experience and technical training with the Victorian Railways and at the Melbourne Technical School. After the first world war, during which he served in the Royal Navy, Mr. Cock joined the construction staff of Messrs. Merz and McLellan in Melbourne, in connection with the electrification of the Melbourne Suburban Railways, and a large power project for the Victorian Electricity Commission. Later he went out to India as one of the supervising engineers, working on railway electrifications. Subsequently he joined the G.I.P. Railway Transportation (Operating) Department. In 1945 Mr. Cock returned to England to take up the post of chief electrical engineer to the Southern Railway. On the nationalisation of the railways in 1948 he was appointed chief electrical engineer to the Railway Executive, which post he relinquished in October, 1950, to take up his present appointment.

## The Royal Scottish Museum

The annual report, covering the year 1951, of Dr. D. A. Allan, of the Royal Scottish Museum, Edinburgh, makes reference to a number of matters of special interest to engineers. They deal in particular with the Museum's department of technology and with the reorganisation which was effected last year in the halls of power and mining and metallurgy. The report says that further improvements in the Hall of Power await the construction of a new floor in the adjacent library, which will connect with and extend the floor space of the hall to the north wall of the building. In the section of the Hall of Mining and Metallurgy, which is devoted to ferrous metals, progress in the production of steel is shown by a series of scale models depicting furnace development. For long, however, this display has lacked any reference to modern electrical methods of steel production. A recent addition, therefore, is a model of a modern Heroult electric furnace on a scale of ¾in to 1ft. Another matter mentioned in the report is that the workshop staff of the Museum has begun the construction of a scale model of the "8ft single" passenger locomotive, which was designed by Benjamin Conner and used on the Caledonian Railway in the late years of the last century. It is also stated that a number of electric telegraph instruments, associated with the work of Sir Charles Wheatstone, have been received on long-term loan from King's College, London. They include an original five-needle telegraph, with transmitting keyboard, and a printing telegraph patented by Wheatstone in 1841.

# British Industries Fair

No. III—*(Continued from page 626, May 9th)*

THE British Industries Fair at Castle Bromwich, Olympia and Earls Court ends to-day, May 16th. In this article we continue our description of some of the engineering exhibits in the Castle Bromwich section of the Fair.

### General Electric Company, Ltd.

The G.E.C. stand is devoted entirely to the activities of the company's research laboratories and their function as part of a large manufacturing organisation. The display is in two sections—one showing the tools of research, and the other the products of research.

An example of a research tool used in mechanical engineering, a test set (Fig. 31) for making measurements on groups of turbine blades, is shown in operation. Its function is to enable the frequency characteristics of the various kinds of wheels and blades to be determined; then, by careful design, it is possible to avoid many major resonances. The equipment demonstrated is used for such frequency measurements. A test set of this kind, installed in the turbine research laboratory at Fraser and Chalmers Engineering Works, Erith, Kent, is also used for some of the many precautionary routine tests carried out on fully bladed wheels before they are put into service. In the laboratory, testing is largely confined to the measurement of the frequencies of blade vibration in stationary full-bladed wheels and on groups of blades where the root and tip fixation is similar to that on actual wheels. To excite blade vibrations, the armature of a moving coil vibrator, similar in principle to a moving coil loudspeaker unit, is attached through a small spindle to the blades under test. The coil of the vibrator is energised by a high-frequency supply obtained from an electronic variable-frequency oscillator and amplifier. The vibration of the blades is detected by a method which relies on the change in capacitance between the vibrating blades and a small plate placed in close proximity to the blade surface. The changes in capacitance change the frequency in a high-frequency circuit, thus giving a frequency-modulated signal which is passed on to a discriminator. The amplified output from the discriminator is applied to the plates of a cathode-ray tube, and the amplitude of the wave track on the oscillograph screen then gives an indication of the amplitude of vibration of the blades. By using a capacitance pick-up and frequency modulation, high sensitivity is obtained, and small vibrations at frequencies above 10,000 c/s can easily be detected.

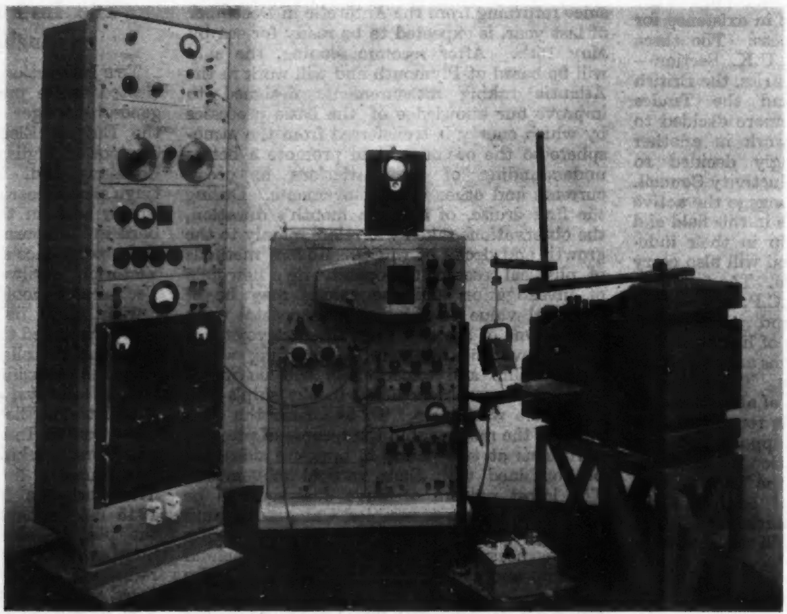

Fig. 31—Measurement of Turbine Blade Frequency—G.E.C.

One of the advantages of testing groups of blades in this way is that it offers a means of obtaining data on new types of blade sections in advance of the complete turbine wheels. This advance information can then be made available to the designer and is of great value, particularly since it is known that remarkably good agreement is obtained between the results of tests on a group of blades and those of tests on the fully bladed wheel.

Turbine supervisory equipment has been designed by the G.E.C. research laboratories to indicate and record three measurements which are of increasing importance with the present trend towards the use of larger units working at higher steam pressures and temperatures. Some of the problems that have arisen because of these operating conditions are associated with the relative displacements and distortions of the turbine rotor and its casing.

Information is required regarding the distortion which the rotor shaft may undergo during the running of the turbine. The shaft may move in its bearings or may bend, thus causing vertical and horizontal eccentricity. Owing to differential expansion between the shaft and the turbine casing, the shaft may move with respect to the casing and so cause axial displacement. Lastly, the mean position of the shaft may change and this will give rise to vertical and horizontal displacement of the shaft.

The equipment developed to give this information includes three sets of detector coils (Fig. 32), which are placed inside the turbine, one to measure axial displacement, one to measure vertical eccentricity and displacement and the last to measure horizontal eccentricity and displacement. Any distortion that may occur can then be read off on the instruments standing some distance from the turbine and giving a clear picture of these distortions taking place in the turbine while actually running. Since these conditions cannot be reproduced on the stand, an experimental

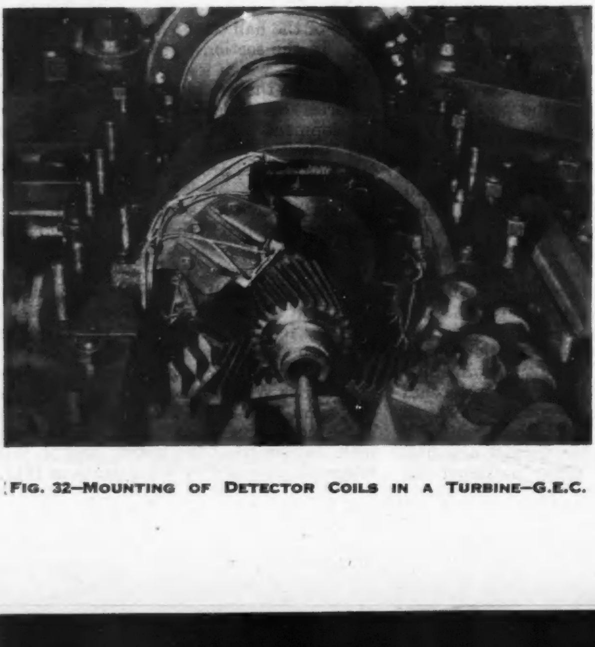

Fig. 32—Mounting of Detector Coils in a Turbine—G.E.C.

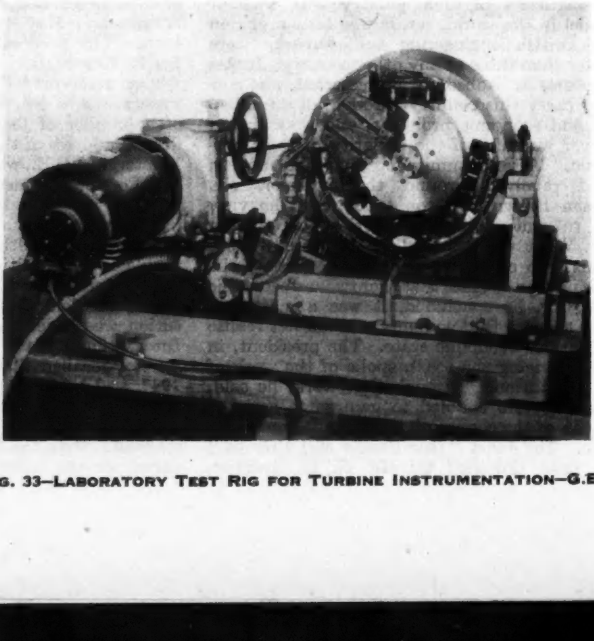

Fig. 33—Laboratory Test Rig for Turbine Instrumentation—G.E.C.

equipment is used to demonstrate the principles involved. This test gear, which is also used to develop and calibrate the instruments, consists of a rotating disc on a shaft (Fig. 33) and simulates shaft motion of the kind encountered in a turbine.

Additional equipment has been developed in order to measure and record the speed of the turbine, using a small high-frequency alternator driven from the turbine shaft. As the turbine speed increases from rest, the output from the generator is fed directly to the indicating and recording instruments until a speed of about 2750 r.p.m. is reached. At speeds above this, the output is automatically switched to a tuned circuit before being fed to the instruments. Two scales are provided on the indicator, the lower is calibrated 0–3000 r.p.m. for the running-up period, while the upper, for the same scale length, indicates 2700 r.p.m. to 3300 r.p.m. The latter scale enables small variations of the rated speed to be detected easily. The recording instrument will, in addition, show three ranges covering 0–3000, 2700–3300 and 3200–3500 r.p.m.

Another exhibit, a valve vibration machine, illustrates methods used in research to improve the life, performance and reliability of electronic valves. In this machine, miniature radio valves are life-tested under conditions of artificially induced vibration of high frequency. The valves, twenty-four of which may be tested at a time, are held in V-blocks which are cut in a vertically mounted tubular carriage. This carriage is supported by wires, and simple harmonic motion is produced by a moving coil motor, the coil being mounted directly on the lower end of the carriage. Electrical and optical monitoring of the motion of the carriage is employed. This machine can be operated in the frequency range 50 to 5000 c/s and at a maximum acceleration of approximately ten times that of gravity. In the design of these machines, particular care is taken to ensure that all the valves on vibration life test undergo the same motion.

### MERRILL PUMPS, LTD.

Three different tube diaphragm pumps for handling a variety of chemical and other corrosive liquids are being shown this year by Merrill Pumps, Ltd., Cavendish Road, Sheffield. One of these pumps is a hand-operated unit and the other two are power driven and have capacities of 12 and 25 gallons per minute respectively, that shown in Fig. 35 having a suction lift of 18ft and a discharge head of 80ft.

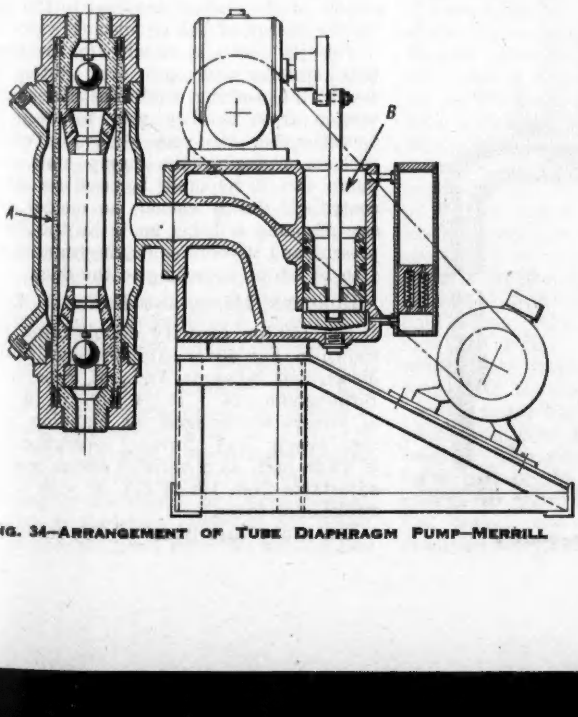

FIG. 34—ARRANGEMENT OF TUBE DIAPHRAGM PUMP—MERRILL

These pumps are all designed on the same working principle, which can be clearly seen in the drawing reproduced in Fig. 34. The pumping unit consists of a chemically inert tube *A* sealed inside a rigid cast iron pulsation jacket and coupled in the pipeline of the liquid being handled. Non-return ball valves are fitted in housings at each end of the diaphragm tube. The pulsation jacket is connected to the cylinder of the reciprocating hydraulic pump *B*, which has a liquid-sealed piston. The annular chamber formed between the diaphragm and the passages to the pumps are filled with hydraulic fluid. As the pump reciprocates its pulsations are transmitted through the hydraulic fluid and the tube to the liquid in the pipeline, thus imparting positive suction and pressure cycles. Liquid sealing of the pump piston is effected by connecting a groove in the cylinder wall to a small reservoir of hydraulic fluid.

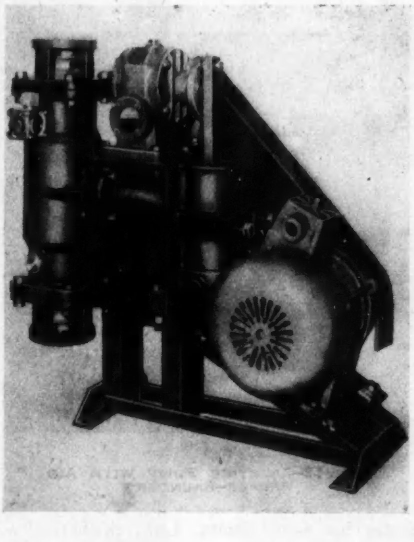

FIG. 35—TUBE DIAPHRAGM PUMP—MERRILL

The pump is motor-driven through a worm reduction gear which has a slotted disc on the output shaft. The connecting-rod of the pump piston is driven through a pin, which can be moved along the slot in the disc to vary the length of stroke, and thus the capacity of the pump. The pump illustrated has a capacity from 1 to 12 gallons per minute.

By fitting twin-tube diaphragm pumping units, operated by a single-cylinder, double-acting pump, a 25 gallons per minute pump can be built. We are informed that a 75 gallons per minute unit will shortly be in production and it will have a twin-cylinder, quadruple-acting transfer port piston pump.

### BLAW KNOX, LTD.

A prominent exhibit amongst the wide variety of contractors' equipment displayed upon the outdoor stand of Blaw Knox, Ltd., 90/94, Brompton Road, London, S.W.3, is an example of "Hico" falsework centering applied to barrel arch roof construction. This design of falsework was described in some detail in our issue of November 16, 1951; it consists essentially of light lattice units of different lengths, which are coupled up as required and supported by special bearing units at each end. The units are coupled together by means of clamps in the top chord of the beam and turnbuckles in the lower beam. By adjustment of the turnbuckles an initial stress is induced in a beam to arch it upwards and compensate for the load imparted and avoid sag when placing the concrete.

In the exhibit the centering is supported by walls built up of steel shuttering; it bridges a span 25ft long, 16ft wide and having a rise of 4ft 9in in the centre of the arch. A built-up beam below the arch enables visitors to inspect the details of typical units and appreciate how they can be easily handled and assembled on site.

Other products exhibited for the first time include a "BK–10" medium motor grader, and a David Brown crawler tractor fitted with a hydraulic angledozer and power control unit.

### FELCO HOISTS, LTD.

The familiar range of lifting equipment made by Felco Hoists, Ltd., 17, Victoria Street, London, S.W.1, includes a useful new hand-operated unit for hoisting weights of 2 cwt over heights up to 5ft. As can be seen in the photograph, Fig. 36, the "Handy-Lift," as it is known, is very small for its capacity, and the fact that it weighs only 5 lb makes it a useful tool, particularly in industrial workshops.

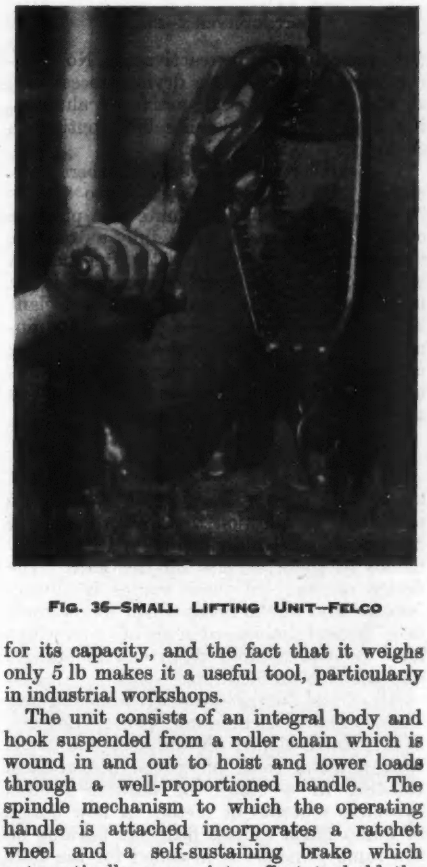

FIG. 36—SMALL LIFTING UNIT—FELCO

The unit consists of an integral body and hook suspended from a roller chain which is wound in and out to hoist and lower loads through a well-proportioned handle. The spindle mechanism to which the operating handle is attached incorporates a ratchet wheel and a self-sustaining brake which automatically comes into effect to hold the load when the handle is released. A hand grip built into the upper part of the body provides a convenient means of holding and guiding the block during working. In the illustration the side plate has been removed to show the way in which the roller chain packs away into the body during hoisting. The chain is fully protected in this pocket at the base of the body, and it can be wound in when it is required to store or transport the unit from place to place.

### BIRLEC LTD.

Equipment for the dehydration of air (particularly compressed air), other gases and certain organic liquids forms the basis of the display by Birlec Ltd., Tyburn Road, Erdington, Birmingham, 24. Three examples of Birlec "Lectrodryer" are on show.

Two of these units are "dual adsorber" equipments, embodying two beds of adsorbent material which come into operation in turn so that, while one bed is on drying duty the other can be reactivated. No interruption is necessary in the drying process and, as the drying material, activated alumina, has a practically indefinite life, continuous drying service is provided.

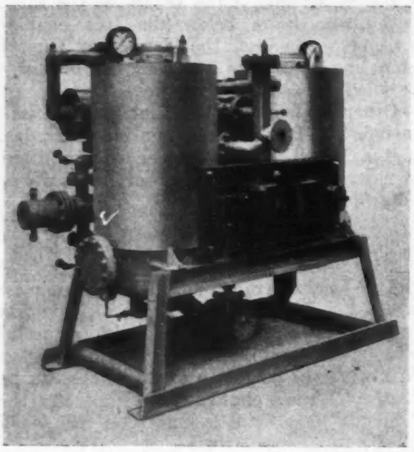

FIG. 37—FULLY AUTOMATIC "LECTRODRYER"—BIRLEC

The smaller of the dual adsorbers is a model "BY1," which is rated to handle 75 cubic feet of air per minute at a pressure of 50 lb per square inch. A fully automatic, time-controlled, valve operating mechanism is used. This automatic operation is an important matter in a widely dispersed plant such as the refinery where eight similar equipments will be used for duties such as drying compressed air for operating control instruments. The unit illustrated in Fig. 37 is similar to the "BY1" unit exhibited.

### PUMPS

A large number of pumps of different kinds and for a variety of duties are exhibited, in addition to those which have been dealt with individually under makers' names in these articles on the Fair. The design of many of these pumps is already familiar and in the notes which follow some brief general details are given of units which have been introduced to extend the ranges of various manufacturers.

All of the pumps made by Mono Pumps, Ltd., of 67, Clerkenwell Road, London, E.C.1, are designed on the same principle, with a metal rotor of special helical form rotating in a stator of natural rubber, synthetic material or metal. A new design of pump made by this firm but working on the same principle is intended for the bulk handling of liquified gases, in which case the pressure on the receiving and discharging vessels must be equalised to prevent vaporisation of the liquid.

As an inherent characteristic of the Mono pump is the seal between the rotor and the stator, which travels from the suction side of the pump to the discharge end when operating, the unit fulfils a double task in this instance as, not only does it form a very convenient method of transferring the liquid, but the seal also tends to isolate the receiving vessel when the pump is stationary. The fact that the pump can be reversed for both discharging and delivering greatly simplifies layout by eliminating the use of a complicated system of cocks.

With the standard range of pumping sets made by Auto Ducts, Ltd., of Uxbridge, are two new models, one small and the other large. The small unit is a petrol engine-driven, self-priming pump, which weighs only 23 lb and is designed to handle up to 1000 gallons per hour. The large pump is a 6in unit driven by an air-cooled diesel engine capable of discharges of up to 60,000 gallons an hour.

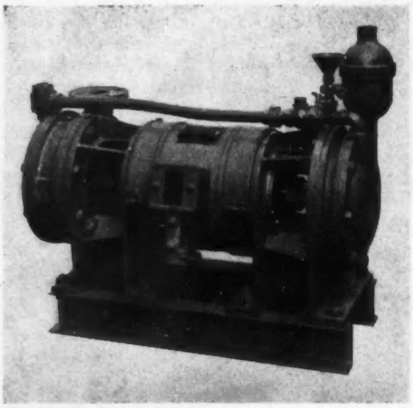

FIG. 38—ELECTRIC PUMP WITH AIR PRIMER—SAUNDERS

The principal exhibit on the stand of James Beresford and Son, Ltd., of Marston Green, Birmingham, 33, is, once again, the well-known submersible electric pump for deep well pumping. This pumping equipment consists of a pump and motor built as a single unit, which is lowered into a well or borehole with only the rising main and electric cable coupling it to the surface. It is built in a range of sizes to cover all pumping requirements from 150 to 110,000 gallons per hour and heads up to 1100ft.

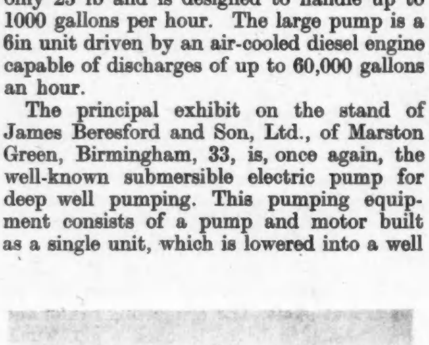

FIG. 39—JET PUMP—GODWIN

Together with large models of the firm's "Stork" self-priming multi-stage pumps is the "Baby" small, single-stage unit, mounted on a trolley. These pumps are made for electric motor or engine drive and are available for outputs of 150 to 1200 gallons an hour and heads up to 140ft.

The "Safran" pumps exhibited by the Saunders Valve Company, Ltd., include an arrangement of a ¾in self-priming pump, shown for the first time. This unit with an independent water-ring air pump, is driven by an 8 h.p. motor, the whole set being mounted on a single shaft. At starting the air pump exhausts air from the main pump and maintains its air-free condition during running to enable the main pump to work on "snore." In Fig. 38 can be seen a 2–2½in pump and a priming pump with a 5 h.p. driving motor mounted between them. The three units are carried on a substantial channel steel frame.

In addition to its range of portable pumping equipment and turbine pumps, Morrison Automatic Pumps, Ltd., Loughborough, is showing its deep well jet pumps for high pressure duties and for the controlled flow domestic pressure water system. In these pumps water is forced at pressure through a jet and, by directing the jet of water through an expanding orifice such as a venturi, it entrains or draws in new water. The expanding orifice serves to convert the speed of the water into pressure and the combined waters are forced up the rising main. From the outlet of the impeller kind of pump used there are two passages, one of which is restricted for taking off the pumped or usable water, the other passage being open and directing water down to the jet. From the venturi above the jet the rising main is taken to the suction side of the pump to give a continuous circulation of water.

The manufacture of jet pumps has now been started by H. J. Godwin, Ltd., of Quenington, Glos., and the working exhibits on this firm's stand includes the unit illustrated in Fig. 39. When this equipment is used for suction lifts of up to 20ft the ejector is incorporated in the pump casing for the purpose of developing a higher pressure than that obtainable from the pump alone. Where the lift to the pump exceeds 20ft the ejector is submerged in the well and is connected to the pump by a two-pipe circuit. Water, drawn into the system at the ejector, is raised to the pump by the energy of the circulating water.

This jet pump is suitable for pneumatic tank systems and open tank duties and, should the working conditions change, conversion from shallow well to deep well operation—or vice-versa—may be effected without changing the pump unit. The pump can, if required, be used for normal centrifugal duties without an ejector. One size of pump is being made by the firm at present and it requires driving motors from ¾ to 1½ b.h.p., according to the duty.

### HORDERN, MASON AND EDWARDS, LTD.

The 150-ton capacity double-crank press shown in Fig. 40 is exhibited by Hordern, Mason and Edwards, Ltd., of Pype Hayes, Birmingham, 24. It is one of a class of presses widely used for blanking, piercing, raising and forming operations. It is made both as a variable-stroke machine, adjustable from 1in to 6in, or with a fixed stroke of up to 8in.

The heavy cast frame of this machine is

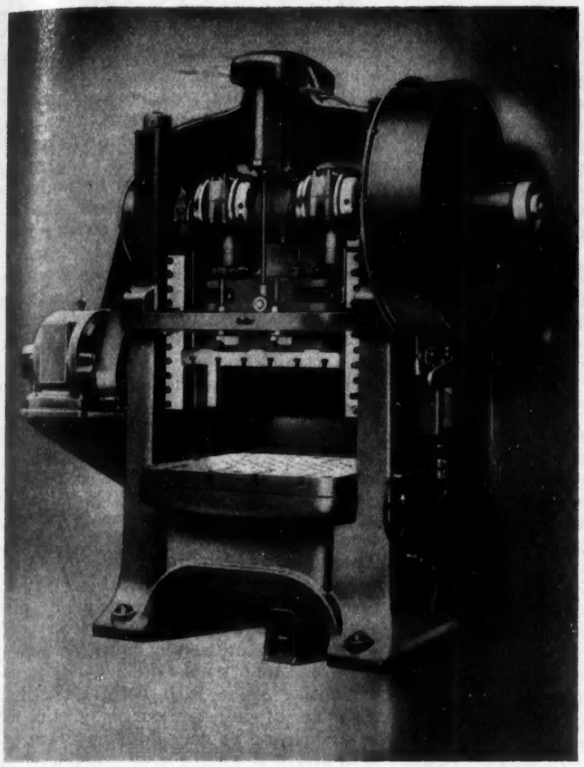

Fig. 40—150 Ton Press—Hordern Mason and Edwards

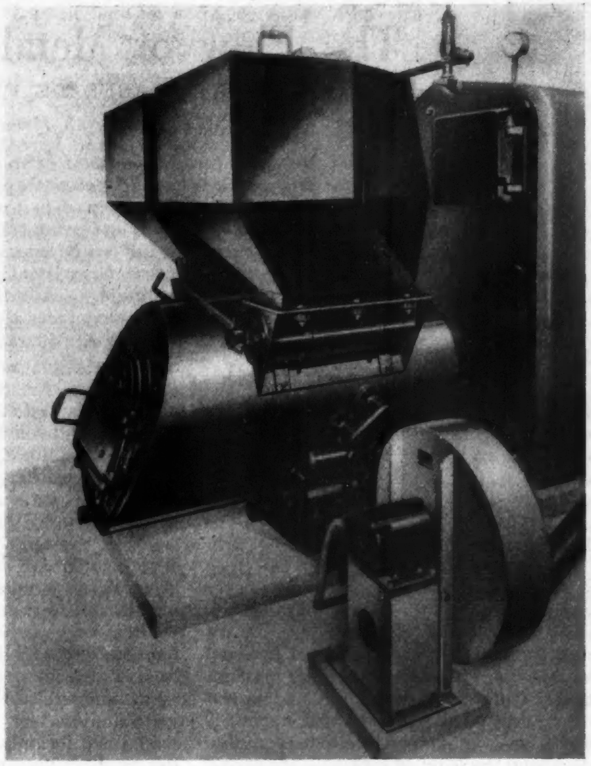

Fig. 41—Automatic Solid Fuel Burner—Auto-Burners

reinforced with four high-tensile steel bars and its backshaft is mounted in ring oiled bearings lined with phosphor-bronze. Drive from the 15 h.p. motor is transmitted through belts, gearing and a non-repeating clutch to a high-tensile forged crankshaft. The steel connecting-rods are arranged for synchronous adjustment and a pneumatically balanced slide works in four faces.

The 45in by 39in bed of the press carries a 43in by 39in bolster plate which is 3½in thick, and the underside of the slide face for top tools is 36in by 20in. On any variable stroke the distance from the bolster plate to the slide is 16½in with the slide at half-stroke, and there is a 4in adjustment from the slide to the bolster plate. Foot-switch-controlled pneumatic gear operates the clutch-actuating mechanism of the press.

### AUTO-BURNERS, LTD.

In Fig. 41 we reproduce a photograph of a new design of solid fuel burner which is being made by Auto-Burners, Ltd., Payle Road, Colnbrook, Bucks, and is intended to provide automatic solid fuel firing for most designs of low temperature hot water and steam boilers. The unit burns coke and coke breeze in addition to most non-caking coals of reasonably small size. Burners of this design are made in nine sizes and to fit them to an existing boiler all that is necessary is to remove the fire door and connect the flame nozzle of the burner with an adaptor of suitable size.

The burner units are largely of fabricated steel construction and consist essentially of a cylindrical water-jacketed combustion chamber on which two hoppers are mounted. Fuel from the hoppers gravitates down into the combustion chamber and builds up over two forced draught inlets. Combustion air is supplied by a fan at the side of a unit and automatic temperature control is obtained by switching the fan motor off and on through a thermostat or "pressurestat" arranged in the main outlet of the boiler. Flames and hot gases from the burning fuel are projected by the flame nozzle of the burner through a hole in the adaptor plate and into the boiler.

When it is required to clear the combustion chamber of ash and clinker the forced draught is cut out and the hopper feed gates closed. A large door at the front of the chamber can then be opened and the live fire can be pushed to the back of the chamber and the ash and clinker drawn out of the front. When the fire is then replaced below the hopper feed chute and the door closed automatic firing can be restarted without delay. The makers point out that the burner is specially designed to burn fuel to a large clinker, which is easily removable in one or two pieces from the top of the fire.

### THOMPSON BROTHERS (BILSTON), LTD.

The largest of many examples of fabricated stainless steelwork to be seen upon the stand of Thompson Brothers (Bilston), Ltd., of Bilston, Staffs, is the first effect of a double-effect evaporator made to the designs of Bennett, Sons and Shears, Ltd. This unit, which has a heating surface of 480 square feet, is of natural convection sloping calandria design, with side separator and recirculation pipe.

One of the firm's standard products is a centre-driven centrifugal machine, illustrated in Fig. 42, used in galvanising, tinning and lead coating for the removal of surplus coating material. In this machine the work is carried in a slightly tapered perforated self-centring basket, designed to hold about 80 lb of small goods, such as nuts and bolts. The basket holder is of welded bar construction and is directly coupled to the spindle of a vertically suspended motor having a special attachment on its case, which houses a heavy-duty roller bearing. This attachment is secured to the lower part of the machine case in such a manner to allow slight axial movement of the basket and basket holder. Shock absorbers and vibration dampers are arranged between the machine casing and motor mounting.

Easy access is provided to all parts of the machine for maintenance and cleaning purposes. To get to the basket holder the upper conical part of the casting can be lifted off without uncoupling any fittings, and large perforated removable doors, designed to prevent the ingress of dirt, give access to the well-ventilated motor compartment.

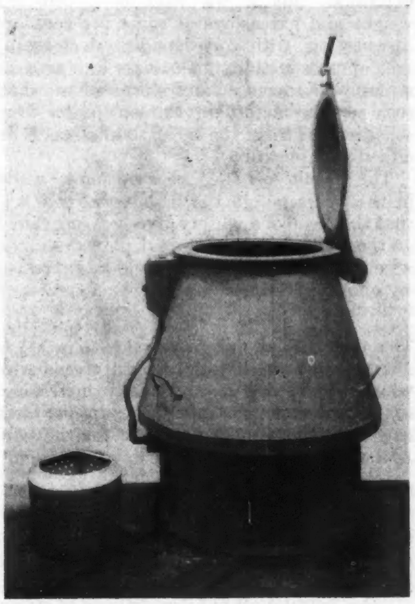

Fig. 42—Direct Centre Drive Centrifugal Machine—Thompson Bros.

Control of the machine is by push buttons grouped close to the lid handle, and an electrical interlock is incorporated making it impossible to operate the driving motor unless the lid is fully closed and fastened.

(*To be continued*)

# The Flow of Metals

By PROFESSOR E. N. da C. ANDRADE, F.R.S.

### No. I

*In this the sixth Hatfield Memorial Lecture, presented before the Iron and Steel Institute on April 30th, the author reviews knowledge about the creep of metals under stress. The metals concerned are lead, tin, copper, iron, cadmium and solid mercury. It is shown that the creep behaviour of all these and many other materials is very similar if allowance is made for temperature and can be expressed (if measured as the extension of a normal polycrystalline wire under constant stress) by the simple equation $l=l_o(1+\beta t^{1/3})e^{\kappa t}$, where t is the temperature. The relative importance of $l_o$, β and κ varies markedly with temperature. The remainder of the lecture discusses this experimentally derived result in an endeavour to express what may be the underlying physical mechanism of creep.*

THE problem for the practical engineer and the metallurgist interested in creep is to be able to predict the slow movement of stressed metals in diverse circumstances, over a long period, from a limited range of tests, frequently short-time tests. The problem for the physicist is, starting with the simplest metals, to break down the creep into its component factors and to discover how they are governed by temperature, crystal form, grain size, the process of recrystallisation, the distribution of external stress and local stress, and other circumstances. Only when these are understood can the effect of alloying and the structural modifications that it produces be profitably studied from the point of view of fundamental properties.

When as a young man I first took up a subject that has interested me ever since, in such leisure as wars and other circumstances have left me, I was convinced that matters would be greatly simplified if the observations were carried out under conditions of constant stress. The simplest way of testing a metal for creep would appear to be to load the rod or wire and measure the rate of extension, but if the load is a constant weight and extensions of some per cent are in question, with corresponding decrease of area of cross section, the load per unit area, or stress, will increase, and since, as we shall see, certain factors in the creep are very sensitive to stress, the increase of stress is an added complication.

The result of the measurements made in the years before the first world war was that the creep of a variety of metals, measured as the extension of a normal polycrystalline wire under constant stress, could be expressed by one simple equation :

$$l=l_o(1+\beta t^{1/3})e^{\kappa t} \quad . \quad . \quad . \quad . \quad (1)$$

The exponential nature of the term $e^{\kappa t}$ is due to the fact that the length of the wire which is creeping is continually increasing, so that a constant rate of creep per unit length gives an increasing rate for the wire as a whole. Taking $\beta=0$, we have

$$\frac{1}{l}\frac{dl}{dt}=\kappa,$$

or, at a given stress, κ expresses a flow of constant rate per unit length, which may be called a quasi-viscous behaviour—quasi viscous, because κ is not proportional to stress.

This analysis thus distinguishes creep into two physically distinct components, the β, or transient creep, which, being proportional to the cube root of the time, diminishes rapidly in rate as time goes on, and the κ, or permanent creep, which proceeds at a constant rate per unit length. There is an immediate extension, expressed by the fact that $l_o$ is not the original length of the wire. This immediate extension is important, but I shall not discuss it now.

Since the creep under tension of the various pure metals tested—lead, tin, copper, iron, cadmium and solid mercury, the last-named being selected for its particular purity—obeys the same equation, it may be asked why, for instance, copper and lead are generally taken to behave quite differently, as far as creep is concerned. The reason is that experiments are usually carried out at atmospheric temperature, at which the two metals are certainly in marked contrast. If, however, we compare copper at a high temperature with lead at room temperature, or lead at a low temperature with copper at room temperature, we find the behaviour very similar.

The one formula covers all the cases, but the relative importance of $l_o$, β and κ varies markedly with the temperature. A rough rule which I have found of use in considering many aspects of the mechanical behaviour of metals is to take as the significant, or reduced temperature θ the ratio of the temperature in question to the temperature of melting, $\theta=T/T_m$, both measured on the absolute scale. Thus, for lead at −180 deg. Cent., θ is 0·16, for copper at 15 deg. Cent., θ is 0·21, for lead at 15 deg. and iron at 444 deg., θ is, respectively, 0·48 and 0·40.

The criticism has been raised that my experiments are of relatively short duration, of a few hours only, which is true. Dr. Hopkin has, however, carried out experiments on the creep of pure lead, using a constant stress device, and has found very close agreement with my formula over a duration of 1000 hours, the total extension being 18 per cent. With a lead containing tin he likewise verified the formula, the duration of the test being 500 hours.

## VARIATIONS OF β AND κ WITH STRESS AND TEMPERATURE

Let us consider a little further these characteristic constants β and κ, which determine normal creep. First of all, how do they vary with stress and with temperature ? It appears that β reaches a limit with stress and that this limit is independent of temperature. I have recently been examining old results on the subject and have found some new and interesting regularities. First of all, it appears that for the one particular metal, lead, for which sufficient results are available, one curve can, by a suitable change of the scale of stress τ, be made to give the variation of β with τ at constant temperature for a wide range of temperatures, i.e.,

$$\beta=f(q\tau)$$

where $q$ is a constant dependent on the temperature. I have recently derived a simple formula expressing this dependence, but I will not detain you with this detail now. I have further found that the sigmoid curve is pretty well represented by

$$y=\int_0^x x^2e^{-x^2}\,dx$$

Again, if we change the scale of β as well as the scale of τ, the same sigmoid curve will answer well for a range of other metals, viz., copper, iron and cadmium.

This sigmoid curve, then, is characteristic of the β, τ relation for many metals and a range of temperatures. This can be explained on general lines by supposing the metal to contain points of weakness or faults, each characterised by a yield stress, the distribution of which according to stress $x$ is given by the probability curve $y=Ae^{-x^2}$, while the contribution of each fault, when it yields, to the creep is proportional to $x^2$. This is not an occasion on which to discuss such points in detail, more particularly as I am struggling with certain aspects of this theory. What I wish to persuade you is that there is a certain generality in the behaviour of β which gives us hope of a further insight into the mechanism of creep.

Turning to the permanent creep, we find that log $x$ is linear with stress. The law is quite general. This law means, of course, that κ increases very rapidly with stress. There have been ingenious attempts to deduce theoretically a general law giving κ in terms of stress and temperature.* Here I shall only insist that κ increases very rapidly with temperature as well as with stress. You have seen that, on the other hand, β reaches a limiting value with both. The general character of the creep curves of pure metals is now clear : at very low temperatures κ is zero and β is small for all possible stresses; we have in general a large immediate extension and a limited transient creep according to $t^{1/3}$. At somewhat higher temperatures κ is still zero and β attains larger values for higher stresses. There is marked transient creep. At still higher temperatures we have β and κ both playing their part, and the typical transient creep survived by permanent creep typified by the behaviour of lead at room temperature. At still higher temperatures the β creep has reached its limit and is relatively unimportant ; it is the permanent creep that predominates throughout.

The $t^{1/3}$ law is of great generality and has proved valid for a wide range of substances. Theoretical physicists, on the basis of elaborations of the dislocation theory, have deduced exponential formulæ to express transient creep ; but, interesting and impressive as they are, they do not agree well with experiment. As a young man I tried many variants of exponential formulæ, suggested by Boltzmann's work, before arriving at $t^{1/3}$. A careful comparison by Dr. Jolliffe and myself of the various proposed formulæ has established a much closer agreement with the $t^{1/3}$ formula than with the other formulæ. Dr. A. J. Kennedy has recently made an examination of the record of transient creep, not only for various metals, but also for miscellaneous substances—mortar, concrete, plasticised polyvinyl chloride, cuprammonium filaments, celluloid, nylon, rubber, and fabric-filled phenoplast. In all cases the results are in excellent accord with the $t^{1/3}$ law. Further evidence for its validity will be produced when I discuss creep under simple shear.

## PHYSICAL MECHANISMS

The transient and permanent flow, expressed by β and κ, have different physical mechanisms. Broadly speaking, the β flow is attributable to slip on glide planes within the crystal grains ; it is a matter of adjustments within the grains. The permanent creep, on the other hand, is due to adjustment of grains as a whole relative to one another; it is a boundary effect. The important experiments of Hanson and Wheeler, who worked with aluminium, have shown that, under conditions favourable for marked $\beta$ flow, close systems of slip bands are well developed within the grains, whereas under conditions favourable for permanent flow, with little $\beta$ flow, there was comparatively little glide within the grains, but marked boundary effects, in the nature of broadening and emphasising the boundary and ultimately the development of intercrystalline cracks. Thus at 250 deg. Cent. rapid straining to an extension of 20 per cent produced very marked slip bands, while the same strain effected in 210 hours, which would be mainly due to permanent creep, gave only boundary effects. Long ago I showed that a rapid preliminary extension or torsion—in fact, "any form of severe preliminary strain"—would put a wire in a state to flow linearly with time from the start. Recently Dr. Kennedy has made a careful study of the effect of a rapid preliminary extension on subsequent flow under constant stress, with the interesting result that after such extension the flow can be represented by the same values of $\beta$ and $\kappa$ as hold for a normal wire, if for $t$ we substitute $t+t_o$, where $t_o$ is a constant which is the bigger the bigger the preliminary strain. In other words, the rapid strain exhausts a part of the $\beta$ flow mechanism, and a large strain exhausts it completely, leaving only the permanent creep. He also showed that a given prestrain was the more effective the lower the temperature at which it was effected, which agrees well with the views that I have put forward. Thus $\beta$ flow can be completely eliminated.

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* *e.g.*, Dushman, S., 1945, "Reviews of Modern Physics." 17, 48 ; Dushman, S., Dunbar, L. W., and Huthsteiner, H., 1944, *Journal Appl. Phys.*, 15, 108.

Another expression of the effect of prestrain is afforded by the experiments carried out by Dr. Charmian Sinclair on the flow of strips cut from rolled sheets of commercial cadmium. The rolling is well known to effect a preferential orientation, in the case of hexagonal metals tending to set the basal plane parallel to the sheet surface; the process also produces elongated grains, with their longest direction in the direction of rolling. These results show the elimination of $\beta$ flow by orientation of the crystal grains.

By other methods $\kappa$ flow can be eliminated, leaving only the $t^{\frac{1}{3}}$ flow. A small addition of tellurium to lead gives a metal showing only $\beta$ flow at atmospheric temperature, and I shall describe later experiments showing that a certain method of stressing produces pure $t^{\frac{1}{3}}$ flow with metal that under the normal method of test shows combined transient and permanent type of flow. Thus the physical distinctness of the two types is well established.

### RECRYSTALLISATION

We may fairly claim, then, that for simple metals the flow can in general be well expressed by formula (1), which resolves it into an immediate extension, a transient or $\beta$ creep and a permanent creep, which means that finally the rate of extension per unit length is constant. Many writers, however, distinguish a fourth state, during which creep proceeds at an ever-accelerating rate. Such accelerated creep is, in most tests, due to working with constant load rather than with constant stress, as I have already pointed out. It can, however, occur when the extension is so small that the decrease of cross section, and consequently, the increase of stress, is insignificant. I think that there can be no doubt that such acceleration is due to recrystallisation under strain. The word "recrystallisation" is used in different senses; I use it here for a process of grain growth during which large crystals are formed by the transfer of atoms from various smaller domains. Some time ago Dr. Charmian Sinclair and I carried out series of careful experiments for creep of short duration with extended wires of a very pure ("Tadanac") lead at various temperatures. The metal was strain-free and of uniform grain size, of about 100 grains per square millimetre. X-ray photographs gave no evidence of preferred orientation. This lead does not recrystallise if left unstrained at ordinary temperatures, but does recrystallise under stress, or, as we shall see, it is better to say, under strain. At −87 deg. Cent. the flow under constant stress was of pure $t^{\frac{1}{3}}$ form. At 0 deg. Cent. there was a stage of marked acceleration, followed by a deceleration of the $\beta$ type, or we can say that the first hardening was followed by a softening, succeeded by a second hardening. Failure was by necking leading to a characteristic knife-edge fracture. It was established that the first stage at which new grains were observed corresponded to the first acceleration and that when the curve finally took the form of a normal creep curve recrystallisation was complete. X-ray examination showed that the large grains formed had a preferential direction of axes which did not differ very much in adjacent grains; this was confirmed by the appearance of the glide planes formed. The extension-time curves at 20 deg. and 25 deg. Cent. were similar to those at 0 deg., but the time intervals to the beginning of recrystallisation, as indicated by the first sign of acceleration, were shorter; at 50 deg. Cent. shorter still and at 100 deg. Cent. the recrystallisation took place almost instantaneously.

These experiments enabled us to establish the conditions which lead to recrystallisation. Rate curves prepared from the extension curves give the first point of inflexion, where recrystallisation commences, as a minimum. It would appear that the conditions for this point might be given by strain, rate of strain or time from the imposition of load. It turns out that it is strain, independent of temperature over the range in which recrystallisation is detected (0 deg. to 100 deg. Cent.) that is effective. The conditions for the effect can be expressed by the formula,

$$s=4\cdot6\tau^{1\cdot6}$$

where $s$ is the percentage extension at which recrystallisation commences and $\tau$ is the stress in kilogrammes per square millimetre. Recrystallisation, then, would appear to depend in a rather complicated way on the amount of glide that takes place in the grains.

In the type of recrystallisation investigated by us, a normal creep according to $l=l_0(1+\beta t^{\frac{1}{3}})e^{\kappa t}$ is followed by a region of accelerated flow which diminishes to a roughly constant rate. I shall have to refer again to recrystallisation under strain when describing our experiments on creep under simple shear, to which I now turn.

### CREEP UNDER SIMPLE SHEAR

The stress distribution during the flow of a plastic rod under axial tension is not the simple matter that the inconsiderate imagine. Creep of a cylinder under torsion has the advantage that the direction of the stress can be easily reversed, and a long time ago I carried out some experiments on lead by this method, but the conditions at different distances from the axis make the detailed interpretation difficult. Things are simpler when we work with an annulus under torsion, since, with suitable conditions, it is easy to measure the shear strain under simple shear, with possible reversal of the direction of the stress.

Some remarkable results have been found with creep carried out under these conditions. The three metals used in a first investigation, carried out by Dr. Jolliffe and myself, were a very pure lead, a commercial lead and commercial cadmium, the grain size for the lead being in the region of 200 grains per square millimetre, and for the cadmium 600. The first finding is that, under these conditions, the shear strain $\gamma$ is given very accurately by a pure $t^{\frac{1}{3}}$ law

$$\gamma=A+Bt^{\frac{1}{3}}$$

even at temperatures where, in tensile tests with the same metal, the permanent creep is marked.

Even at high temperatures the $t^{\frac{1}{3}}$ law is obeyed under conditions of simple shear. At such temperatures in tensile test the permanent flow, linear with time, predominates.

The very pure lead shows recrystallisation effects of the same kind as those under tensile tests of which I have already spoken. The strain $\gamma_r$ at which the recrystallisation effect begins is given by

$$\gamma_r=1\cdot21\times10^{-6}\sigma^{1\cdot7}$$

which is of the same form as the formula already given for recrystallisation under tensile strain. The exponent cannot be fixed very accurately: it is possible that it is 1·66 in both cases, i.e., $1\frac{2}{3}$, which would bring in the fatal $\frac{1}{3}$ again.

*(To be continued)*

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## Institution of British Agricultural Engineers

AT the annual general meeting of the Institution of British Agricultural Engineers, which was held in London on Wednesday of last week, Mr. F. E. Rowland, M.I.E.E., was elected president for a second year. The report of the council, which was presented at the meeting, shows a steady increase in membership, the total in all grades at the end of last year being 1071. Since the beginning of this year a further ninety-five members have been elected. Reference is made in the report to the Institution's activities in agricultural engineering education, and to the establishment of a National Diploma in Agricultural Engineering. The number of applications being received for this year's and subsequent diploma examinations indicates that before long the annual entry will be larger than originally contemplated. At a luncheon following the meeting, the toast of "The Institution" was proposed by Lord Carrington, who urged that in agriculture to-day full use must be made of the best technical and practical knowledge. There was no doubt, he said, that those engaged in agricultural engineering could give great assistance with their knowledge, experience and enterprise; the greater their professional standing the better, whether they were engaged as teachers in universities and agricultural colleges or in industry or on farms. In his response, the president, Mr. F. E. Rowland, said that agricultural engineering was continuously becoming more complex, and if our position both at home and overseas was to be maintained, engineers of the highest calibre would be needed. In this age of unprecedented technical development, however, there was a grave danger that technical efficiency might be pursued as an end in itself. However efficient our machines and methods, Mr. Rowland remarked, the human touch was even more important. The community could only benefit and, indeed, survive if each individual was prepared to make his maximum contribution to progress, without material reward being the principal objective.

# Protective Measures for Radioactive Isotopes

By V. E. PULLIN, C.B.E.

*Direct exposure to X-rays or to the penetrating gamma radiation which is emitted by radium, radon, or the artificial radioactive isotopes, is highly inimical to health. Furthermore, these radiations are scattered by objects upon which they fall and this scattered radiation is equally dangerous to personnel. This consideration must govern any contemplated use of X- or gamma-radiation for radiography. Special attention should be given to protective measures in technique, local transport and storage. The nature of the problem is here studied and what must be done to ensure safety for personnel under these particular headings is defined.*

THE use of gamma radiation, particularly in the sphere of engineering applications, has many advantages over X-rays. In certain fields it is probable that X-radiography will always be preferred to gamma radiography because of the shorter exposure time and the increased clarity or contrast of the resulting radiographs. This is probably true, for example, in the case of high-pressure boiler welds, which by their nature are ideal subjects for inspection by X-rays.

Radium emanation, or radon, is a source of very high gamma ray energy. Large quantities of it (upwards of one Curie) may be absorbed into a charcoal pellet of very small size, something less than a square millimetre. Thus, this particular substance has very great value where high definition in a radiograph is essential. The area of intense gamma ray emission in the case of radon more nearly approximates to a point source than is possible with any other radioactive substance. For certain important examinations, such as the inspection of Grade I welding, this characteristic is often a deciding factor in the choice of a gamma ray source.

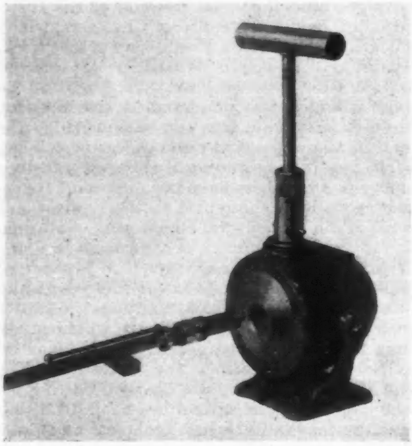


FIG. 1—CONTAINER AND EXTRACTING ROD

A grave demerit of radon is the fact that it decays so quickly, its half-life being only 3·8 days.

There are many radiographic applications, both actual and potential, which demand much greater mobility with regard to the source of radiation than can be achieved by X-ray equipment, and it is in such cases that radioactive sources of gamma radiation will be preferred in spite of some comparative disadvantages.

The radioactive isotopes commonly used in radiography have different characteristics; for example, some are of much higher energy than others. Consequently the problem of protection varies depending upon the particular source under consideration, and its quantity. For example, radium C has very high gamma ray energy, upwards of 2 MeV. Cobalt 60 has an energy of approximately 1·33 MeV, tantalum 182, 1·2 MeV, and iridium 192, 0·6 MeV. There are technical considerations which determine the use of one or other of these sources for a particular purpose. Of course, the higher the gamma ray energy the more penetrating is the radiation, and where thick specimens are to be examined this is a very important factor. In these days radium salt is not very often used for radiography because of its extremely high monetary value, which, of course, is a factor inhibiting the use of very large quantities; furthermore, the relatively large bulk of the source militates against good radiographic definition. For the examination of thick specimens radioactive cobalt has much to recommend it for two cogent reasons: it is a very high energy source and it has a very long half-life period (5·3 years). Radioactive tantalum has also comparatively high gamma ray energy of the order of 1·2 MeV, but its half-life period is very much shorter, only 120 days. Radiactive iridium is an extremely useful gamma ray source for thinner materials, having a gamma ray energy of approximately 0·6 MeV. Using this isotope, one may expect slightly better contrast than in the case of cobalt or tantalum. The half-life period of iridium is seventy days.

Having decided on the use of one of the radioactive sources for radiographic examination of metals, it is necessary in the first place carefully to consider precisely what kind of work is contemplated and to define the most suitable and safe arrangements. It is first necessary to decide the most appropriate and convenient concentration or quantity of the source; secondly, its transport from the place of storage to the job; and finally, the technique to be employed in its actual use in inspection.

The question of protection both in storage and use becomes more difficult as the quantity of the source increases. Consequently, where mobility is an important factor—as it is, for example, in the examination of welded ship structures—small concentrations are very desirable, and as such welding usually involves comparatively thin plates, quite small concentrations will not necessitate unduly long exposures. Adequate protection is always difficult to achieve in site radiography in a ship, and the smaller quantities of dangerous material are better and safer to manipulate. On the other hand, where the isotope is destined for use in one special place in a works and is required for comparatively thick specimens and where exposure times become an important consideration, then large quantities of radioactive material are indicated. If it is possible to assign one particular place or area for gamma radiography which can be suitably fenced off, then protection becomes a much simpler matter.

At the same time, it is the writer's definite opinion that the quantity of a high-energy isotope such as cobalt should, at any rate under present conditions, be restricted to about one Curie.

The A.E.R.E. at Harwell supply radioactive sources for radiography in permanently sealed standardised metal capsules, and the customer is required to provide a container or "bomb" into which the capsule is introduced. Incidentally, it is incomprehensible why this sinister word "bomb" should be so widely used to describe the container for radio-active capsules; the benign word "container" seems to be so much more appropriate and certainly it is not so alarming.

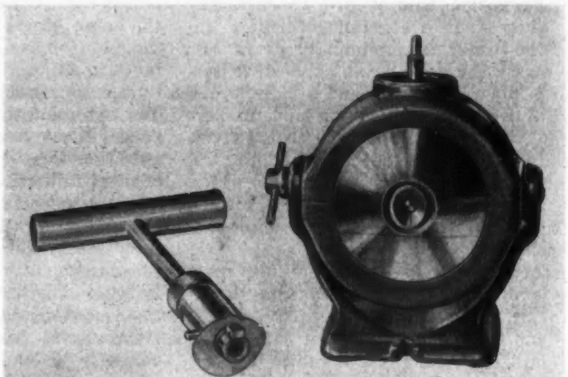


FIG. 2—CONTAINER WITH HANDLE

There are several of these containers on the market; their design and size vary depending upon the concentration and gamma ray energy of the radio-active material they are to contain. They are usually supplied with small wheeled trolleys fitted with a long handle for convenience and safety in moving the container from place to place. These containers are sometimes fitted with a handle which might suggest that they are designed to be carried by hand. This practice, however, should, on general principles, be forbidden. If it does become necessary to lift or move the container by hand then the operation should be a matter of seconds or, at the most, a minute or two. Figs, 1, 2, 3, 6 and 7 illustrate these commercially available containers made by Solus Schall, Ltd., of 18, New Cavendish Street, W.1, and Gamma-Rays, Ltd., of Smethwick.

Figs. 4, 5, 8, and 9 illustrate a very attractive and ingenious model of an isotope container permanently mounted on a wheeled trolley. It was designed by Mr. J. C. Rockley, of the Radiological Section of the A.I.D. Test House at Harefield; the container was also constructed in the A.I.D. Test House. It is designed for a 500mC cobalt 60 source, and the maximum permissible dose of radiation is not exceeded at a distance of 1m from the closed container.

Exposures may be made, without removing

the source from the container, by removing one or both of the side plugs. This operation is carried out by means of a rod over 1m in length and the operation is so arranged that at no time is the operator in the direct beam of gamma rays which emerge from the open port. Alternatively, the plug in the domed top of the container can be removed and used for panoramic exposures, the source being attached to a small extension piece at the tapered end of the plug. The most ingenious feature of this container is the fact that at no time during any manipulative operation is the operator's body exposed to the direct beam of radiation.

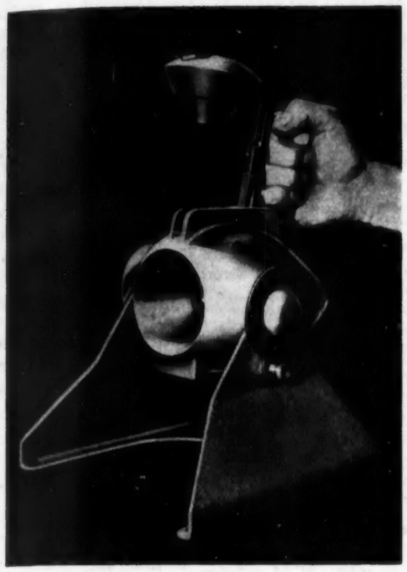


FIG. 3—CONTAINER WITH REMOTE CONTROL OPENING

Now let us consider storage of these radioactive sources in a firm. This must be so arranged that when the source is not in use it is put into such a place or position that the radiation emitted by it is innocuous to anyone in the vicinity. For convenience let us consider a one-Curie source of the isotope cobalt 60. If the capsule containing this source were unshielded by any absorbing material whatever, the safe distance for personnel would be of the order of 35ft. If, on the other hand, the isotope capsule were placed in a container having metallic lead walls of 3in in thickness, then the safe distance would be of the order of 6ft, and if this container were then to be placed in a concrete chamber having, say, 6in walls, the safe distance would be very small indeed. When we talk of "safe distance" we mean that a person standing at that distance from the source for eight hours a day for a five-day week would receive less than the maximum allowed dose of radiation—that is to say, under 0·5 rontgens per week. Incidentally, the amount of radiation (say, gamma radiation) passing a given point in a given time is measured in rontgens per hour (r.m.h.).

On the other hand, if we have to consider small concentrations or lower energy isotopes this, of course, would mean that the distances we have quoted above could be very materially reduced. It would appear, therefore, and it has been shown to be convenient in practice, that the use of a suitable container stored in a concrete safe or subterranean chamber is a satisfactory method of storing isotopes when not in use.

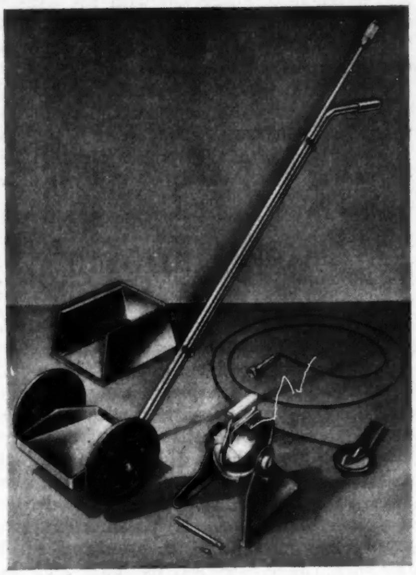


FIG. 6—CONTAINER AND TRANSPORT TROLLEY

It should be remarked that if the radioactive agent we are considering is either radium or radon then the storage chamber should be ventilated.

We have now to consider the question of the transport of the radiographic source container from its place of storage to the site where it is to be used, and this matter claims special consideration. Here the time factor is very important.

Where it is possible it is very desirable to allocate one specific place, preferably removed from other buildings, where all gamma ray radiography is carried out. This site may conveniently be railed off at a suitable distance. Under such conditions we rely upon distance for protection and it would be unnecessary to consider expensive buildings having protective walls or barriers. Such a site could be in close proximity to the place where the radioactive source is normally stored. When arrangements have been completed for the exposure to start, the trolley containing the container should be brought as quickly as possible from its safe to the site of the work.

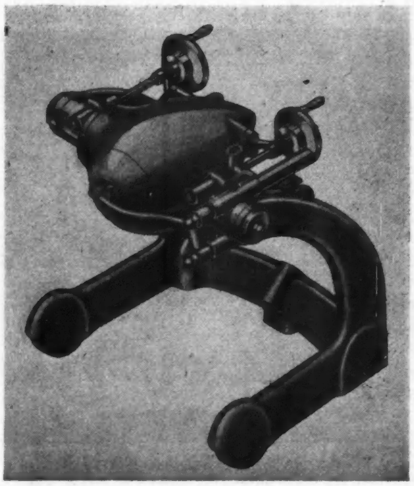
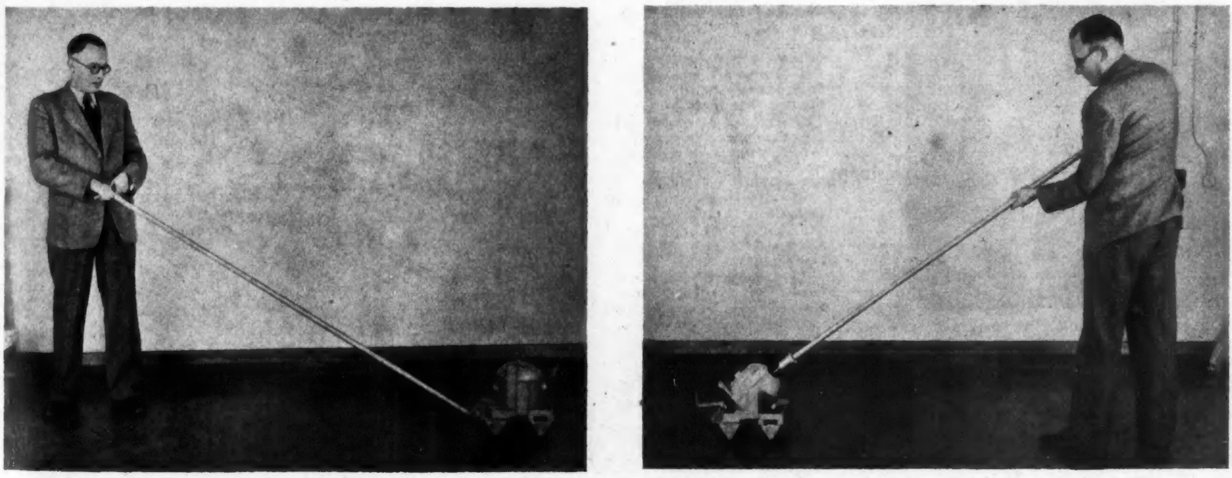


FIG. 7—ONE-CURIE ISOTOPE CONTAINER (COBALT 60)

In some cases, however, it will be necessary to convey the radioactive source to different parts of a works for special exposures, where the time of the transport journey may be appreciable. We remarked above that if we are concerned with a source of one Curie of cobalt 60 housed in a container having lead walls of 3in in thickness, then at a distance of 6ft an operator would be safe for a forty-hour week. To use a 6ft handle on the trolley would be awkward and in many cases inconvenient. If, however, we were to substitute a 3ft handle we should be subjecting



FIGS. 4 & 5—HAREFIELD ISOTOPE CONTAINER SHOWING (RIGHT) REMOVAL OF TOP PLUG the operator to a much heavier dose of radiation, approximately four times the amount in fact; hence it would only be safe for him to remain in this position for ten hours a week, or two hours a day for five days; but we must remember that quite a lot of distance could be covered during two hours every day. In fact, it is inconceivable that transport of a radiographic source would go on for anything like this time in any ordinary works. Therefore it would seem that a container such as we described on a trolley with a 3ft handle would be a reasonably safe arrangement for the transport of a large quantity of high-energy radioactive material in the ordinary course of events. A container having 3in lead walls would be heavy and bulky, but it might be possible to have a thinner-walled container if the safe transport time were to be rigorously defined and strictly enforced. This modification would only be allowable, however, assuming that the permanent storage arrangements were adequate.

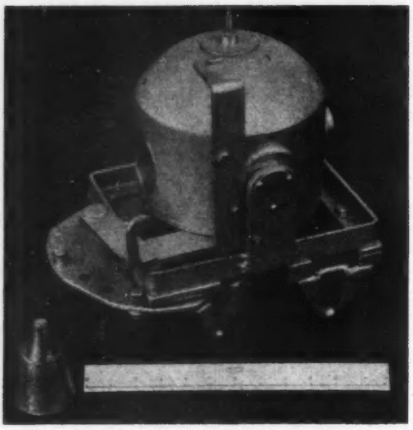


FIG. 8—HAREFIELD CONTAINER WITH SIDE PLUG REMOVED

The safe time for transport in any set of circumstances, therefore, should be clearly stated, and to do this the nature and thickness of the walls of the container must be known, as must the quantity and gamma ray energy of the capsule. Between separate exposures the source in its container should always be returned to its storage chamber.

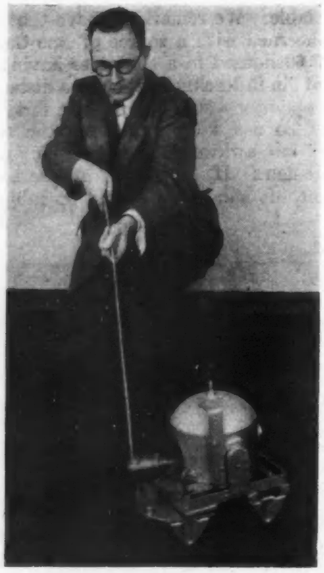


FIG. 9—REMOVING SIDE PLUG

We are now in a position to consider the actual technique of exposure.

In a great many cases the specimen to be examined may be radiographed without removing the radioactive capsule from the container. Most of the containers in common use have a device whereby a window may be opened by remote control, allowing the gamma ray energy to emerge in one direction and, wherever possible, this technique should be used. In other cases, however, where it may be necessary to radiograph a large number of specimens at one exposure, or where it is desirable to introduce the source into any awkward or small structure or cavity, it becomes necessary to remove the capsule from the container. This may be done by means of what is known as the "rod technique." All manufacturers supply special rods of their own design adapted for the quick and safe removal of the capsule, and subsequently this rod with the capsule attached may be placed in the desired position so that the radiography may be carried out in the required manner. It is superfluous to add that, whatever device may be used to remove the capsule, the operation should be performed in as short a time as possible and with the longest possible rod consistent with effective and accurate manipulation of the side plug and capsule.

All preliminary arrangements, setting up of specimens, identification marking, placing in position of films and cassettes, alignment of radiation, and so on, should be done before the source is brought to the site and using a dummy capsule mounted on a precisely similar rod to that which is used for handling the radioactive source itself. The actual source should only be brought to the site and placed in position at the last moment.

Data is available at Atomic Energy Research Establishment giving full details of radioactive sources that are available, together with their rate of decay. Safe distances for personnel and the effectiveness of absorbing materials are also available for customers' information and convenience. Firms using these substances for radiography should make quite sure that the staff responsible for their use have all these data available and understand their significance. They should also be specifically instructed in the potential dangers involved in this work.

The generally known and ordinary precautions which are observed in industrial radiography, such as blood counts, the N.P.L. Film Service, carrying of portable ionisation chambers, are more than ever necessary when undertaking radiography by means of high-energy gamma ray sources.

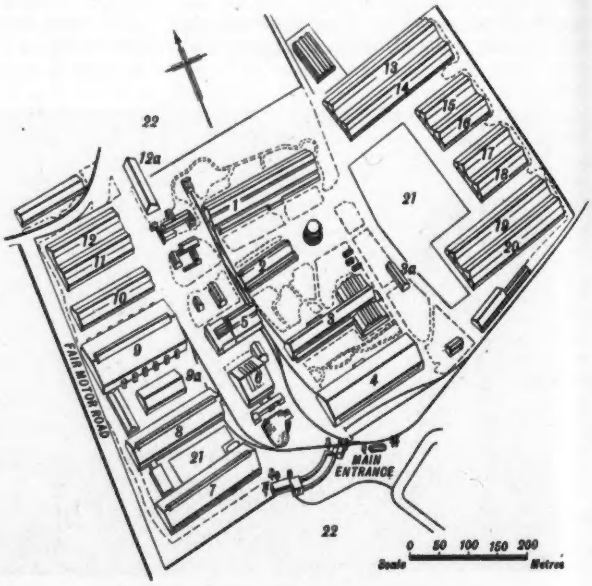
# Hanover Technical Fair

## No. I

FOR the first time in the short history of the Hanover Technical Fair, which opened on Sunday, April 27th, and closed on Tuesday, May 6th, there were no machine tools. They will be shown at the Second European Machine Tool Exhibition, which will take place in Hanover from September 14th to the 23rd next. The absence of machine tools made it possible to give more generous space to iron and steel, machinery and electrical exhibits, and the number of exhibitors nearly reached the figure for last year, over 150 foreign firms being represented. The total exhibition area this year included two further exhibition halls and larger open-air spaces, and has now reached nearly 200,000 square metres.

The official opening ceremony was held in the Niedersächsenhalle, Hanover, on Sunday morning, April 27th, when the guests were welcomed by the Minister-President of the Landes Niedersachsen, Herr Heinrich Wilhelm Kopf. He spoke of the growing success of the fair, owing to its central position and the work and initiative which had been shown by the people of Lower Saxony. There was still much to be done, he said, by way of improving the transport facilities, particularly air travel and the autobahn road connections. The next speaker was the General Director, Dr. Gustav Möllenburg, the president of the Vereins Deutscher Maschinenbau-Anstalten e.V., who dealt at some length with the general position in German industry and its productive capacity, which, he said,

1—Pumps, compressors, lifting appliances and testing machines.
2—Power transmission and gearing.
3—Iron and steel, foundry machines and welding appliances.
3a—Collective exhibition of tools and appliances.
4—Prime movers, boilers, food preparing, rubber and plastics machinery.
5—Workshop tools and precision machinery.
6—Chemicals and plastic materials.
7—Textile machinery.
8—Woodworking machines.
9, 9a, 10, 11, 12, 12a—Electrical machinery and equipment.
13—Tools, polishing and hardening equipment, optical and surgical appliances.
14—Iron and steelware, grates and domestic machines.
15—Rubber exhibits.
17—Sewing machines.
18—Printing and packing machines.
19 and 20—Office and business machinery and equipment.
21—Open-air exhibits.
22—Car parks.



ARRANGEMENT OF EXHIBITION BUILDINGS

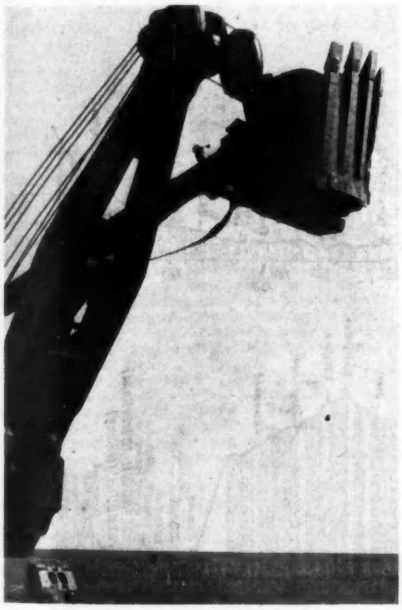
was now in full flood. The exhibits showed a full cross-section of every branch of engineering industry and many new designs were to be seen. There was need, he felt, to increase production if the defences of Western Europe were to be strengthened and the living standards were to be maintained. The technical fair could be looked upon as an expression of the solidarity of the country, which during the past years of reconstruction had had the duty of making destroyed houses into homes, turning ruins into factories and transforming disheartened men into happy workers.

*Growth of Hanover Technical Fair*

| Year | 1947 | 1948 | 1949 | 1950 | 1951 | 1952 |
|---|---|---|---|---|---|---|
| Number of exhibition halls ... | 5 | 6 | 7 | 16 | 21 | 23 |
| Area of halls in square metres | 17,160 | 28,824 | 51,637 | 73,603 | 144,000 | 151,650 |
| Area of open-air exhibits in square metres | 8,000 | 11,000 | 16,000 | 30,000 | 40,000 | 45,000 |
| Number of firms exhibiting ... | 521 | 1,120 | 1,273 | 1,786 | 2,645 | 2,636 |

The final speech was delivered by Franz Blücher, the Vice-Chancellor and the Bundes-Minister for the Marshall Plan. The fair, he said, had better than those of previous years, fulfilled its duty of giving a clear view of the development of German production. He liked to think of a single economic plan for the whole of Europe which would serve all countries by permitting freer exchange of goods and payments.

The accompanying plan shows the general arrangement of the halls and open-air exhibition spaces and the table covering the years 1947 to 1952 shows the steadily increasing size of the fair. Since last year two further halls have been added (Nos. 9a and 12a). This year engineering products in general formed nearly half the exhibits and electrical exhibits about one-fifth. Two halls were devoted to textile machinery and for the first time there was a separate hall for chemical and plastic exhibits. Below we give a short account of some of the engineering exhibits.

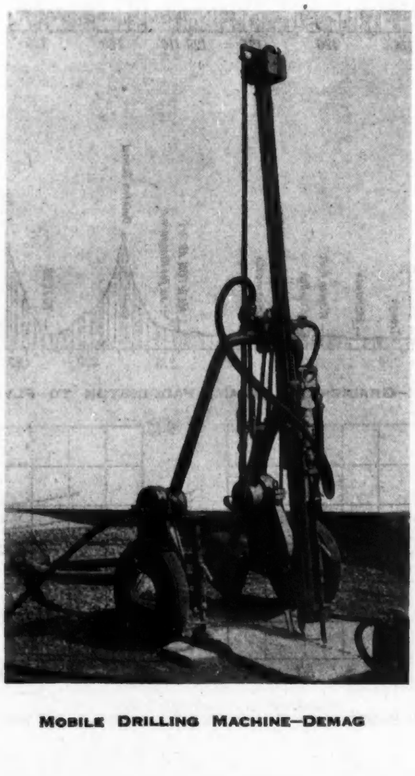


UNIVERSAL EXCAVATOR—DEMAG

A noteworthy item in the iron and steel sections was that arranged by the Ruhrstahl A.G. of Henrichütte Hattingen, Ruhr. This firm specialises in the production and machining of steel forgings and castings, welded constructions and grey iron castings. Its display included an example of a welded column and cylinder casing unit weighing about 9000kg, which is one of eight on order for a 6000 b.h.p. marine diesel engine. The unit is built of 16·22mm steel plate and has a total height of 6·500mm or over 20ft.

Outside Hall 3 was another Ruhrstahl exhibit consisting of a Doxford-type marine engine crankshaft, weighing 42 tons and designed to run at 115 r.p.m. It is in three parts, bolted together and has five main bearings and four main crank throws and eight throws for the side driven scavenge pumps. The cranks, cheeks and pins are made as single parts and shrunk together. Other exhibits on the firm's stand included cast iron diesel engine liners and forged and machined parts for chemical plant, also connecting-rods and crankshafts for rolling mill engines. Some of these diesel engine components are for the Götawerken A/B of Gothenburg, Sweden. The firm is represented in this country by Mr. E. Murray Kerkhoff of 317, Boldmere Road, Sutton Coldfield, Birmingham.

One of the larger independent exhibits was that of Demag A.G., of Duisburg, and it comprised a representative collection of the products of the main works and the associated companies. In a pavilion at the centre of the stand was a large model of a modern blast furnace and electric steel smelting furnaces complete with auxiliary machinery and equipment. One of the largest working exhibits was the 2·3 cubic metre bucket-excavator mounted on tracks and driven by a four-cylinder, two-stroke "Modag" diesel engine. These machines are built in eight sizes covering a range of from 0·4 to 7 cubic metres bucket capacity. They can be driven electrically or by steam, if preferred, and are convertible, with suitable modifications, for use as dragline, dragshovel, grab excavators or cranes.



MOBILE DRILLING MACHINE—DEMAG

The bucket excavator is shown in the accompanying illustration. Its deep box-section welded boom at its centre carries a swinging sleeve through which the tubular bucket arm passes. The bucket arm is traversed by means of a toothed rack, which engages with bevel and spur gears arranged within the boom. An arm of tubular construction was chosen on account of its resistance to torsional and transverse forces and with its mechanical drive is designed to withstand all tensile and bending stresses and to deal with torsional stresses which are caused when the bucket is digging on one side only. These machines are made at the Demag excavator works at Düsseldorf-Benrath.

In addition to excavators and cranes, the firm displayed a range of compressed-air operated hammer-drills and carbide-tipped drilling tools. A new exhibit was the light drilling carriage complete with drill and air compressor which has been designed for rock and concrete drilling in vertical, horizontal and inclined positions. The machine, which is illustrated herewith, is mounted on rubber-tyred wheels and can be quickly moved from place to place.

The British representatives of the Demag A.G. are the D.M.M. (Machinery), Ltd., of 119, Victoria Street, Westminster, London, S.W.1.

(*To be continued*)

◆

## Codes of Practice

### IMPULSE CLOCK AND TIMING SYSTEMS

Code 327.403. The Council for Codes of Practice for Buildings has now issued in final form "Impulse Clock and Timing Systems." The code forms part of the series dealing with telecommunication services in the group of codes on electrical installations in and about buildings. It deals with the design and installation of impulse-controlled clock and timing systems for various types of premises and provides for visual or audible time indication, means of time recording, or any desired combination of these facilities.

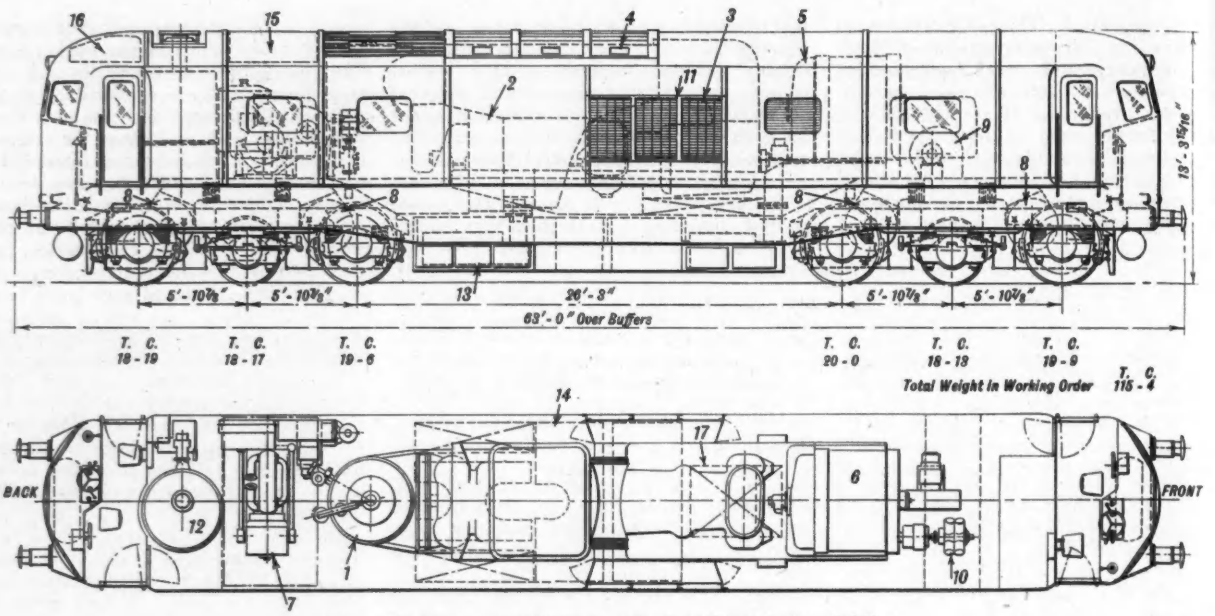
Copies may be obtained from the British Standards Institution, 24/28, Victoria Street, London, S.W.1, price 3s. post free.

### BELL AND CALL SYSTEMS

Code 327.401. The Council for Codes of Practice for Buildings has now issued in final form, "Bell and Call Systems." The code is part of the series dealing with telecommunication services in the group of codes on electrical installations in and about buildings. It deals with the installation in private dwellings, hotels, schools, factories, &c., of bell and indicator call systems, including time bells, burglar alarms and watchmen's supervisory services. Copies may be obtained from the British Standards Institution, 24/28, Victoria Street, London, S.W.1, price 3s. post free.

### SURFACE WATER AND SUBSOIL DRAINAGE

Code 303. The Council for Codes of Practice for Buildings has now issued in final form "Surface Water and Subsoil Drainage," which describes methods of collection and disposal of surface water and of ground or subsoil water. It is limited to drains not exceeding 12in in diameter such as would serve housing schemes, schools, factories and individual buildings, and is complementary to, and should be read in conjunction with, Code 301, "Building Drainage," with which it is intended to be incorporated when that code is revised. Copies may be obtained from the British Standards Institution, 24/28, Victoria Street, London, S.W.1, price 2s. post free.


1
2
3
4
5
6
7
8
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10
11
12
13
14
15
16
17
5'-10⅞"
5'-10⅞"
26'-3"
5'-10⅞"
5'-10⅞"
63'-0" Over Buffers
13'-3 15/16"
T. C. 18-19
T. C. 18-17
T. C. 19-6
T. C. 20-0
T. C. 18-13
T. C. 19-9
Total Weight in Working Order T. C. 115-4
BACK
FRONT

FIG. 1—GENERAL ARRANGEMENT OF LOCOMOTIVE No. 18,000

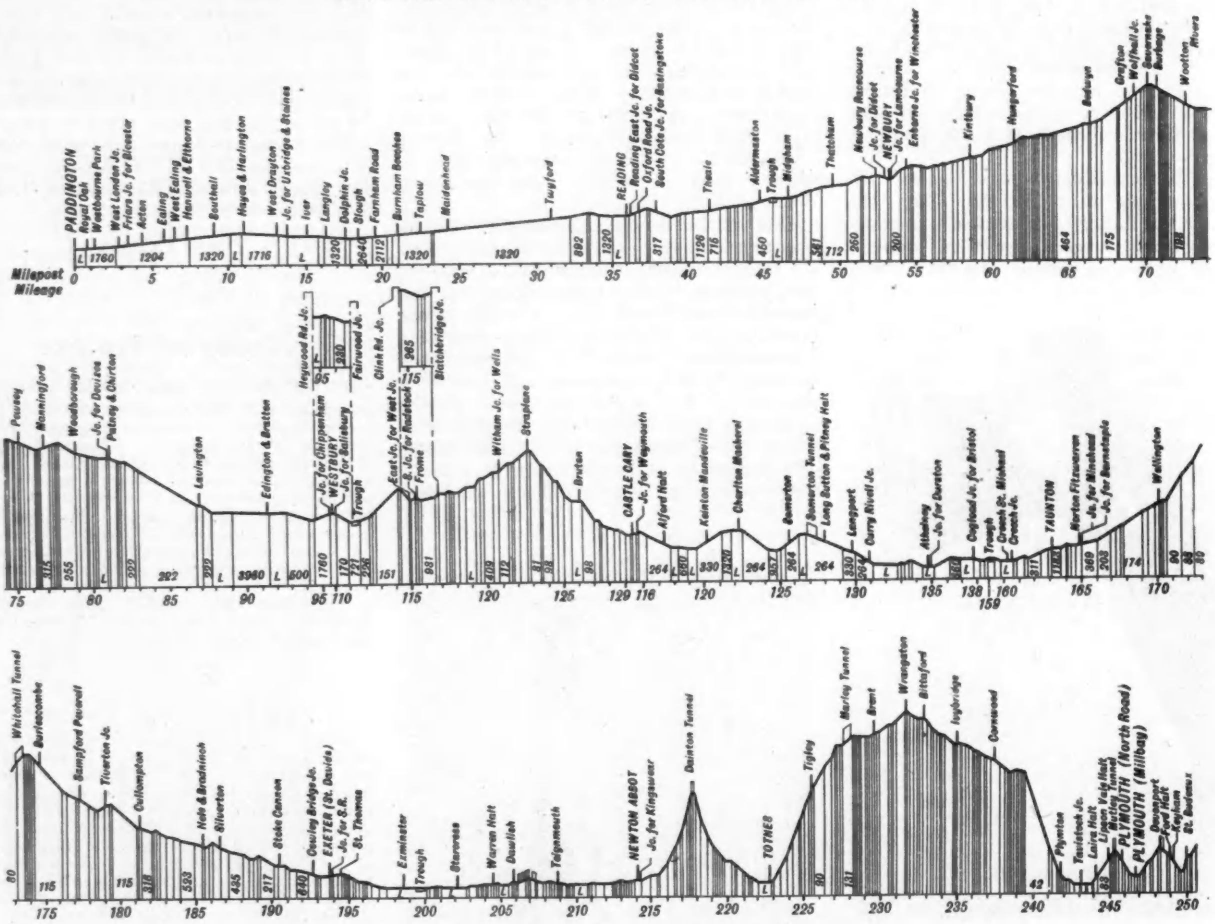

FIG. 2—GRADIENT DIAGRAM, PADDINGTON TO PLYMOUTH

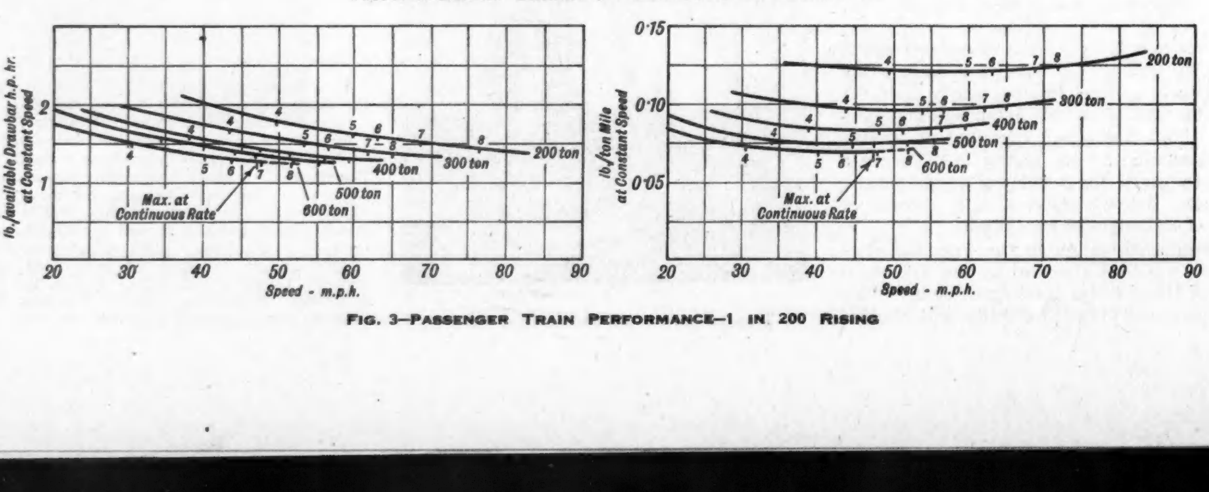

FIG. 3—PASSENGER TRAIN PERFORMANCE—1 IN 200 RISING

# Tests on Gas Turbine Locomotive No. 18,000

*In a report received from British Railways particulars are given of interesting performance and efficiency tests carried out on gas turbine locomotive No. 18,000 in the Western Region of British Railways. This report gives particulars of power output, fuel consumption and efficiency over the entire working range of the locomotive and for various journeys between Paddington and Plymouth with scheduled trains.*

WE have received from British Railways a report upon performance and efficiency tests carried out on the Brown Boveri gas turbine locomotive No. 18,000 in the Western Region. This locomotive, which was delivered at Swindon in February, 1950, and entered revenue-earning service the following May, was described in detail in THE ENGINEER of May 19 and 26, 1950, and an article by Mr. O. S. Nock in the issue of July 13, 1951, dealt with some of its runs in service. The tests, which are the subject of this report, are part of a testing programme of various types of locomotives being made under the direction of the testing committee for British Railways. The object of the tests was to obtain performance and efficiency characteristics, not only for operational purposes in respect to the locomotive itself, but also for comparison with those of steam locomotives.

The report points out that since the locomotive was built in 1949 it has run 46,000 miles in this country, which corresponds to an aggregate running time of 1130 hours. In March, 1950, the compressor failed and in its rebuilding provision was made to obviate such a failure in future, but this entailed alterations which, it was stated, would result in some loss of efficiency. From time to time adjustments have been made by the makers to the combustion conditions, and the results presented in the report refer to the locomotive as running in September, 1951.

In the tests a series of runs with a dynamometer car was carried out in September, 1951, and in the report particulars are given of the power output, fuel consumption and efficiency of the locomotive over its entire power range, as well as for particular journeys between Paddington and Plymouth with scheduled trains.

Before dealing with the report some general notes on the construction and design of the locomotive are given and the arrangement of the engine and its equipment can be seen in the drawing we reproduce on the opposite page. It has an $A_1A$—$A_1A$ wheel arrangement with identical driving cabs at each end, and its leading particulars are given in the table below.

*Leading Particulars of Gas Turbine Locomotive No.* 18,000

| | |
|---|---|
| Length over buffers ... ... | 63ft |
| Diameter of driving wheels ... | 48½in |
| Diameter of carrying wheels ... | 38in |
| Continuous rating of gas turbine unit... ... ... ... ... ... | 2500 h.p. |
| Tractive effort at wheels : | |
| During starting ... ... ... | 31,500 lb up to about 21 m.p.h. |
| Continuously ... ... ... | 12,400 lb at 64 m.p.h.<br>8,400 lb at 90 m.p.h. |
| Maximum speed ... ... ... | 90 m.p.h. |
| Number of driving axles and traction motors ... ... ... | Four |
| Weight of mechanical part ... | 118,000 lb |
| Weight of thermal part ... ... | 72,000 lb |
| Weight of electrical part ... | 53,000 lb |
| Weight of stores (fuel, water, sand, &c.) ... ... ... ... | 17,000 lb |
| Adhesive weight ... ... ... | 174,000 lb |

The power unit of the locomotive—consisting of the gas turbine, compressor, heat exchanger, combustion chamber and geared generator assembled on an auxiliary frame—takes up the larger part of the machine room, which is partially subdivided by the air intakes to the compressor. At the combustion chamber end of the locomotive is an auxiliary diesel generator set, a train heating boiler and one of the traction motor fans. The other fan is placed at the main generator end, together with the two exhauster-compressor sets for the brakes.

The mechanical portion of the locomotive was designed and built by the Swiss Locomotive and Machine Works of Winterthur and consists essentially of two similar three-axle bogies, the main frame and the coach body. Each bogie has a fabricated box-section main frame of high-grade steel supported on the roller bearing axleboxes through helical springs. The axleboxes are guided by two vertical cylindrical pins inside which are screwed rods used for holding the boxes in a

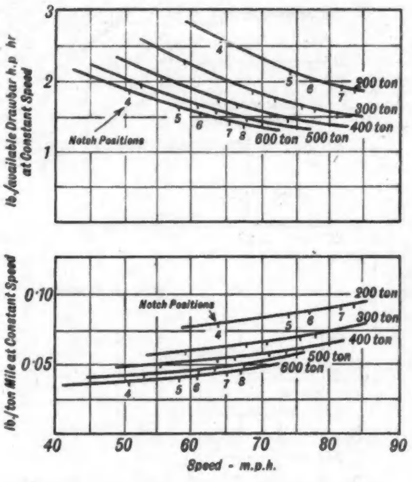

FIG. 4—PASSENGER TRAIN PERFORMANCE—LEVEL

*Test of Western Region Gas Turbine Locomotive No.* 18,000

*Trains.*—Down : 3.30 p.m. ex Paddington to Plymouth. Slipping one coach at Heywood Road Junction and stopping at Taunton and Exeter.
Up : 7.15 a.m. ex Plymouth to Paddington. Stopping at Totnes, Newton Abbot, Teignmouth, Dawlish, Exeter, Taunton and Westbury.

*Table of Averages*

| Run number ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... | 1 | 3 | 2 | 4* |
|---|---|---|---|---|
| Date ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... | 11/9/51 | 13/9/51 | 12/9/51 | 14/9/51 |
| Direction ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... | Down | Down | Up | Up |
| Weight of locomotive, tons ... ... ... ... ... ... ... ... ... ... ... ... | 119·2 | 119·2 | 119·2 | 119·2 |
| Load and number of vehicles : | | | | |
| Paddington–Westbury, tons tare/number of vehicles ... ... ... ... ... ... | 395 for 12 | 395 for 12 | — | — |
| Westbury–Exeter, tons tare/number of vehicles ... ... ... ... ... ... ... | 359 for 11 | 359 for 11 | — | — |
| Exeter–Plymouth North Road, tons tare/number of vehicles ... ... ... ... | 239 for 7 | 239 for 7 | — | — |
| Plymouth North Road–Newton Abbot, tons tare/number of vehicles ... ... ... | — | — | 228 for 7 | 227 for 7 |
| Newton Abbot–Exeter, tons tare/number of vehicles ... ... ... ... ... ... | — | — | 388 for 12 | 356 for 11 |
| Exeter–Paddington, tons tare/number of vehicles ... ... ... ... ... ... ... | — | — | 388 for 12 | 386 for 12 |
| Distance, actual, miles ... ... ... ... ... ... ... ... ... ... ... ... ... ... | 225·2 | 225·2 | 225·2 | 153·2 |
| Distance under power, miles ... ... ... ... ... ... ... ... ... ... ... ... | 182·2 | 189·4 | 185·6 | 120·2 |
| Ton-miles, excluding locomotive (actual miles) ... ... ... ... ... ... ... | 78,000 | 78,000 | 82,400 | 53,600 |
| Time : Booked running, minutes ... ... ... ... ... ... ... ... ... ... ... | 259·0 | 259·0 | 275·0 | — |
| Actual running, minutes ... ... ... ... ... ... ... ... ... ... ... | 252·3 | 251·4 | 269·0 | 186·1 |
| Overall (including stops), minutes ... ... ... ... ... ... ... ... | 265·5 | 264·4 | 296·3 | 220·0 |
| Actual less drifting and idling (under power), minutes ... ... ... | 209·9 | 204·0 | 213·4 | 175·6 |
| Average speed, m.p.h. ... ... ... ... ... ... ... ... ... ... ... ... ... | 53·6 | 53·7 | 50·2 | 49·4 |
| Work done, d.b.h.p./hour ... ... ... ... ... ... ... ... ... ... ... ... | 2,520 | 2,824 | 2,621 | 2,135 |
| Average d.b.h.p. ... ... ... ... ... ... ... ... ... ... ... ... ... ... | 721 | 831 | 736 | 729 |
| Average d.b. pull, tons ... ... ... ... ... ... ... ... ... ... ... ... ... | 2·25 | 2·59 | 2·46 | 2·47 |
| Oil, total used: Heavy, lb. ... ... ... ... ... ... ... ... ... ... ... ... | 4,960 | 5,230 | 5,450 | 4,340 |
| Light, lb. ... ... ... ... ... ... ... ... ... ... ... ... | 224 | 223 | 250 | 186 |
| Total, lb ... ... ... ... ... ... ... ... ... ... ... ... | 5,184 | 5,453 | 5,700 | 4,526 |
| Oil, lb/d.b.h.p./hour ... ... ... ... ... ... ... ... ... ... ... ... ... | 2·05 | 1·93 | 2·17 | 2·12 |
| Oil, total used under power : Heavy, lb ... ... ... ... ... ... ... ... | 4,496 | 4,727 | 4,759 | 3,970 |
| Light, lb ... ... ... ... ... ... ... ... | 177 | 172 | 180 | 148 |
| Total, lb ... ... ... ... ... ... ... ... | 4,673 | 4,899 | 4,939 | 4,118 |
| Oil rate : | Overall total Under power | Overall total Under power | Overall total Under power | Overall total Under power |
| Heavy, lb/hr ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... | 1,121 ... 1,282 | 1,210 ... 1,350 | 1,102 ... 1,337 | 1,181 ... 1,353 |
| Light, lb/hr ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... | 50·6 ... 50·6 | 50·6 ... 50·6 | 50·6 ... 50·6 | 50·6 ... 50·6 |
| Total, lb/hr ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... | 1,171·6 ... 1,332·6 | 1,260·6 ... 1,400·6 | 1,152·6 ... 1,387·6 | 1,231·6 ... 1,403·6 |
| Oil rate drifting and standby, heavy and light, lb/hr ... ... ... ... ... ... | 550·6 | 550·6 | 550·6 | 550·6 |
| Gross calorific value of fuel oil : Heavy, B.Th.U./lb ... ... ... ... ... ... | 18,530 | 18,580 | 18,680 | 18,740 |
| Light, B.Th.U./lb ... ... ... ... ... ... | 19,610 | 19,590 | 19,530 | 19,490 |
| Oil per mile, lb ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... | 23·02 | 23·20 | 24·2 | 28·3 |
| $\frac{\text{Work done at drawbar}}{\text{Total heavy fuel oil used}} \times \frac{100}{1}$, per cent ... ... ... ... ... ... ... ... ... ... | 6·95 | 7·42 | 6·56 | 6·68 |
| $\frac{\text{Work done at drawbar}}{\text{Heavy fuel used under power}} \times \frac{100}{1}$, per cent ... ... ... ... ... ... ... ... ... | 7·67 | 8·20 | 7·51 | 7·29 |
| $\frac{\text{Work done at drawbar}}{\text{Total heavy and light fuel oil used}} \times \frac{100}{1}$, per cent ... ... ... ... ... ... ... ... | 6·66 | 7·09 | 6·25 | 6·39 |
| $\frac{\text{Work done at drawbar}}{\text{Total heavy and light fuel oil used under power}} \times \frac{100}{1}$, per cent ... ... ... ... | 7·40 | 7·91 | 7·22 | 7·02 |

* Test 4 terminated at Savernake

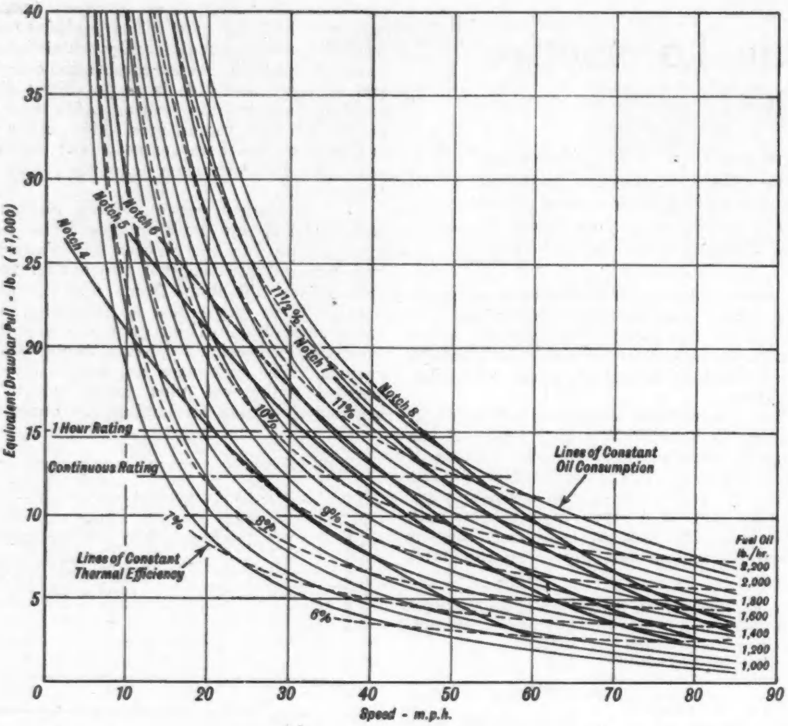

FIG. 5—DRAWBAR PULL CHARACTERISTICS

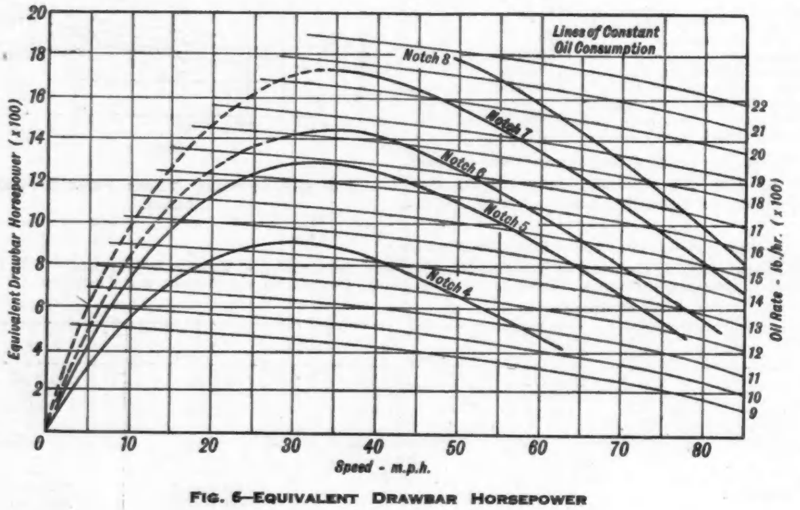

FIG. 6—EQUIVALENT DRAWBAR HORSEPOWER

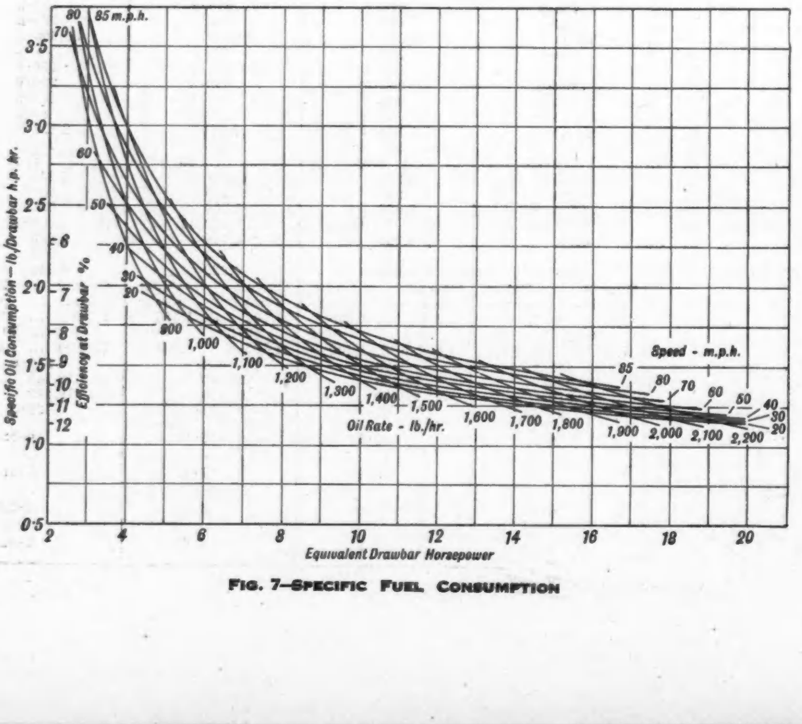

FIG. 7—SPECIFIC FUEL CONSUMPTION

downward position and for fixing friction dampers. An adjustable dry friction damping device damps out the vertical oscillations. The outer axles on each bogie are motor driven through gears and are held sideways on the driving side only.

The fabricated sheet steel underframe girder of the locomotive has riveted cross stretchers and stiffeners, and built into this frame between the bogies are the fuel and water tanks, and a series of storage compartments for batteries, &c. The entire thermal unit is assembled on an auxiliary frame supported in the main frame on a three-point suspension.

The single-shaft, open-cycle gas turbine has a nominal output of 2500 h.p., its overall thermal efficiency at full load being 16·9 per cent. The corresponding fuel consumption is 0·87 lb per h.p. hour and the turbine and compressor speed 5300 r.p.m. With an inlet temperature of 1100 deg. Fah. this turbine has an exhaust temperature of about 480 deg. Fah. The twenty-two-stage compressor has a delivery pressure of 36 lb per square inch and it is calculated that at full load the compressor induces approximately 1·5 tons, or 44,300 cubic feet, of air per minute.

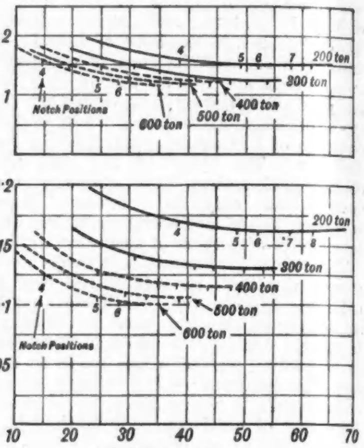

FIG. 8—PASSENGER TRAIN PERFORMANCE
1 IN 100 RISING

The turbine-generator gear ratio is 6·6 to 1 and the ratings of the main generator, which is a multi-polar machine with commutating pole and compensating windings, are as follows:

| | |
|---|---|
| Continuous rating ... ... ... | 2340A at approx. 675V |
| One-hour rating ... ... ... | 2640A at approx. 760V |
| Maximum working voltage ... | 760V |
| Maximum working speed ... | 875 r.p.m. |

This generator supplies current to four d.c. traction motors, which are continuously connected in parallel, through motor isolating switches and a reversing switch. These series-wound traction motors have a continuous rating of 397kW, 720V, 585A, 1550 r.p.m. and a one-hour rating of 394kW, 636V, 660A, 1290 r.p.m.

An auxiliary d.c. generator driven by a six-cylinder oil engine, in addition to supplying separate excitation current for the main generator, provides all the power for the auxiliary machinery, either direct or through a battery which it charges.

### LOCOMOTIVE TESTS

The method of testing adopted was an adaptation of the controlled road testing system as developed at Swindon for steam locomotives. In the adaptation the locomotive was worked for relatively long periods in selected controller notch positions while records were taken of available effort and power at the drawbar with respect to speed and oil consumption. The analysis of these records enabled the characteristics shown in the report to be prepared.

Positive displacement precision oil meters were fitted in the heavy oil flow and return lines to the burner. Because of the pressure and temperature conditions one of the meters had to be totally enclosed within a special pressure vessel and both had to have special rings and clearances arranged for the operating pistons. The meters registered electrically in the dynamometer car on the distance and time base records and also actuated magnetic counters. Temperatures of the oil as it passed through the meters were noted on the temperature measuring equipment of the car. On each test the oil was sampled for determination of calorific value and other particulars, including specific gravity at working temperatures.

Generator output was measured by the metering equipment of the car. Gas temperatures before the turbine and the turbine speed were observed at short intervals throughout the tests from the locomotive's own indicators.

It was found possible to carry out the tests on normal revenue-earning trains without interfering with schedules. The trains chosen were as follows :—

Down : 3.30 p.m. Paddington to Plymouth. Slipping one coach at Heywood Road Junction and stopping at Taunton and Exeter.

Up : 7.15 a.m. Plymouth to Paddington. Stopping at Totnes, Newton Abbot, Teignmouth, Dawlish, Exeter, Taunton and Westbury.

The gradient section of the route is given on a special diagram we reproduce in Fig. 2.

As tests the trials were satisfactory ; the trial on the last day had to be curtailed at Savernake due to the development of trouble in the bearing of the measuring wheel of the dynamometer car but this did not materially affect the value of the results.

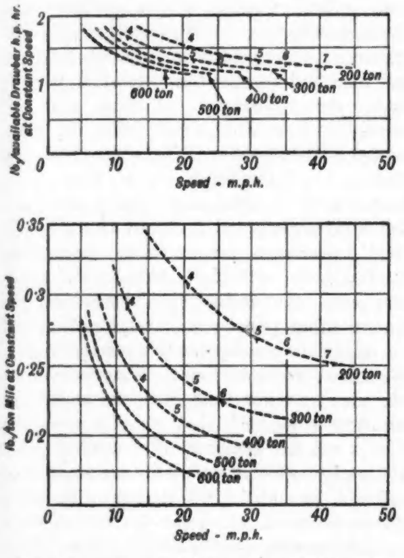

FIG. 9—PASSENGER TRAIN PERFORMANCE—1 IN 50 RISING

The major part of the working range of the locomotive was covered ; working in control notch 9 was insufficient.

The drawbar characteristics obtained are shown in Figs. 5 and 6 and in them the equivalent drawbar effort and power are directly related with speed, controller notch, heavy fuel oil consumption and efficiency and correspond to the drawbar characteristics obtained for steam locomotives with which an instructive comparison may be made. It may be noted, for instance, that the efficiency contour enclosures characteristic of the steam locomotive are absent and that maximum operating efficiency of the gas turbine locomotive coincides with high power output as opposed to a rate of working about two-thirds of the maximum in the case of the steam locomotive.

In Figs. 3, 4, 8 and 9 the drawbar characteristics are translated into operating terms for working on the level and on rising gradients of 1 in 200, 1 in 100 and 1 in 50, for passenger train loads of 200 to 600 tons. In each of these figures the small figures on the curves indicate the notch position. It should be noted in Figs. 3, 8 and 9 the performance shown by dotted lines can be sustained for short periods only and must be referred to traction motor limiting current.

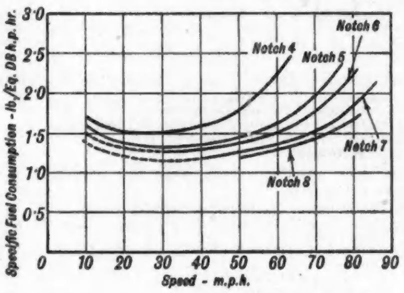

FIG. 10—SPEED AND FUEL CONSUMPTION CHARACTERISTICS

The specific fuel consumption relative to power at the drawbar is shown in Figs. 7 and 10 when using heavy fuel oil with a gross calorific value of 18,630 B.Th.U. per lb.

A general examination was made of the fuel oils used in the first day's runs only. Determinations of the calorific value were made in respect of all of the samples and determinations of specific gravity at elevated temperatures of the heavy fuel oils only. The results of a general examination of two samples of heavy fuel oils were as follows :—

| | Sample No. 1 | Sample No. 2 |
|---|---|---|
| Viscosity, Redwood No. 1, at 100 deg. Fah., seconds... | 836 | 790 |
| Specific gravity at 60 deg. Fah./60 deg. Fah. ... ... | 0·944 | 0·942 |
| Flash point (closed), deg. Fah. ... ... ... ... ... | 216 | 200 |
| Pour point, deg. Fah. ... ... | 45 | 45 |
| Ash, per cent ... ... ... | Less than 0·01 | 0·03 |
| Sediment, per cent ... ... | 0·02 | 0·02 |
| Water content, by volume, per cent ... ... ... ... | Nil | Nil |
| Clearness ... ... ... ... | Opaque | Opaque |
| Type ... ... ... ... ... | Dark mineral | Dark mineral |

The calorific values of the eight fuel oils examined were as follows :—

*Calorific Value*

| Sample No. | Fuel oil | Calorific value (gross) B.Th.U. per lb |
|---|---|---|
| 1 | Heavy | 18,530 |
| 2 | Heavy | 18,680 |
| 3 | Heavy | 18,580 |
| 4 | Heavy | 18,740 |
| 5 | Light | 19,610 |
| 6 | Light | 19,530 |
| 7 | Light | 19,590 |
| 8 | Light | 19,490 |

The specific gravity at elevated temperatures of the four heavy fuel oils are given in the table below.

The efficiency characteristic of the power unit is shown in Fig. 11, when using heavy fuel oil with a calorific value of 18,630 B.Th.U. per lb, ambient temperature 66 deg. Fah. It should be noted that the efficiency at the generator coupling is calculated from generator output curve assuming maker's generator efficiency of 94 per cent.

*Specific Gravity at Elevated Temperatures*

| Temperature, deg. Fah. | Specific gravity | | | |
|---|---|---|---|---|
| | Sample No. 1 | Sample No. 2 | Sample No. 3 | Sample No. 4 |
| 60 | 0·944 | 0·942 | 0·945 | 0·942 |
| 180 | 0·900 | 0·897 | 0·898 | 0·897 |
| 200 | 0·892 | 0·889 | 0·890 | 0·889 |
| 220 | 0·885 | 0·882 | 0·882 | 0·882 |
| 240 | 0·877 | 0·874 | 0·874 | 0·874 |
| 260 | 0·870 | 0·867 | 0·866 | 0·867 |
| 280 | 0·862 | 0·859 | 0·858 | 0·859 |
| 300 | 0·855 | 0·852 | 0·850 | 0·852 |

In Fig. 12 data is given relative to fuel consumption and gas temperature before the turbine, as measured during the tests, using heavy fuel oil of the same calorific value.

The report concludes with a table showing average results of the tests as normal dynamometer car trials on service trains. This table, which is reproduced on page 665, contains much interesting information, such as the proportion of the total running time which is spent in standing at stations and in running without effort being exerted at the drawbar, and the oil consumption—approximately one gallon per minute—during these periods.

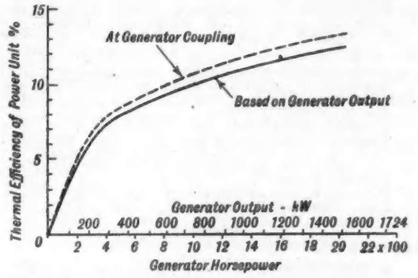

FIG. 11—EFFICIENCY OF POWER UNIT

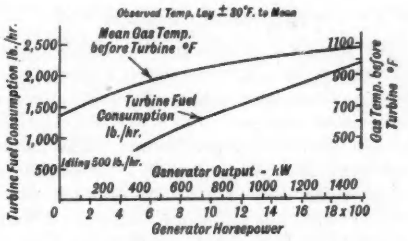

FIG. 12—TURBINE FUEL CONSUMPTION

The figures given of mean effort at the drawbar relative to maximum effort and average efficiency relative to the maximum, are of interest. In comparing these with Figs. 5 and 6 only the oil consumption and efficiency in relation to time under power should be used (i.e., when a useful effort is being exerted at the drawbar).

Reasonable agreement will be noted if this comparison is made, the results appertaining to the down trains being more comparable than those of the up trains due to the number of stops and drifting periods in the latter case.

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**INSTITUTION OF MINING AND METALLURGY.**—The council of the Institution of Mining and Metallurgy has announced the following awards : the Gold Medal of the Institution to Dr. G. K. Williams, in recognition of his work in connection with research into the metallurgy of lead and zinc and the development of metallurgical processes : honorary membership of the Institution to Mr. E. Hooper, past-president, in recognition of his services in the development of the Institution from its foundation sixty years ago, and to Mr. E. D. McDermott, A.R.S.M., past-president, in recognition of his services to the Institution and to mining and metallurgical education ; the Consolidated Gold Fields of South Africa, Ltd., Gold Medal for 1951 to Mr. H. E. Jeffery, A.C.S.M., A.M.I.M.M., for his paper, "Notes on Fire Prevention and Fire-Fighting, with Particular Reference to the Kolar Gold Field," and the Consolidated Gold Fields of South Africa, Ltd., Premium of Forty Guineas to Mr. R. Cornthwaite and Mr. F. Juretic, for their paper on "Sinking of Irwin Shaft at Roan Antelope Copper Mine" ; the "Arthur Claudet" Student's Prize to Mr. T. A. A. Quarm, for his paper on "A Method for the Preparation of High-Purfty Indium Metal" and the "William Frecheville" Student's Prize to Mr. A. P. Millman, for his part authorship of the paper on "Heavy Metals in Vegetation as a Guide to Ore : a Biogeochemical Reconnaissance in West Africa."

THE ENGINEER

Vol. CXCIII MAY 16, 1952 No. 5025

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## TRANSPORT POLICY

AT the time of the general election last autumn it was known that, if elected to power, the Conservatives intended to denationalise transport. But how they intended to set about it was obscure. The issue last week of a White Paper, some abstracts from which are printed on another page of this issue, has not wholly dissipated that obscurity. For that White Paper does not define a complete plan for the reorganisation of transport in this country. Rather is it confined to indicating the lines of thought of the Government in its attempt to formulate a more detailed plan. It is, in fact, a rough sketch rather than a finished drawing and may well be found to have been subjected to amendment by the time the Bill it foreshadows comes to be presented to the House of Commons. We hope it will be amended.

When the Transport Act of 1947 (then a Bill) was first introduced by the Labour Government, there was nothing unreasonable in the socialist desire to nationalise the railways. Unification seemed, in fact, a natural final step in the evolution of the organisation of railways in this country, following reasonably, though by no means necessarily, upon the welding of many private companies into the pre-war groups. It could be expected, given much more time than has yet passed, to lead to further economies in operation similar to those that were the consequence of grouping. But a similar argument could not be applied to road transport. It is true that in that industry some large concerns had emerged as a consequence of mergers of smaller ones. But many small road haulage concerns operated both efficiently and profitably in a highly competitive field. It is to be doubted, in fact, whether, organised in large concerns, road transport can effectively retain the individuality and flexibility that helps to give it for certain traffics so marked an advantage over the railways. Certainly the very rapid increase in the number of "C" licensed vehicles from 487,151 at the end of 1947 to 733,044 at the end of 1950—as compared with some 40,000 vehicles under the control of the Road Haulage Executive—provides evidence that many traders find it more profitable to operate their own vehicles than to use public, or even privately owned "A" or "B" licensed road transport; and a considerable proportion of the large number of "C" licensed vehicles must be engaged upon long hauls in competition with the Executive's lorries. The handing back of publicly owned long-distance road haulage to private operators, as proposed by the Government, might check the increase of "C" licensed vehicles by restoring the flexibility that has been lacking in the nationalised industry. But it would certainly exacerbate road-rail competition. Nor can it be argued that competition would not matter because road transport has become more important to this country than rail (according to British Road Federation statistics there are over 1½ million people engaged in the former compared to about 600,000 in the latter). The railways still play a very significant part in passenger transport and particularly in the conveyance of bulk goods. The net ton-miles of minerals, coal and coke handled in the first quarter of the present year amounted, for instance, to 1,278,348, as compared with a similar figure of 594,330 for merchandise and livestock. The railways, as the White Paper states, "remain an essential element in transport and cannot be allowed to fall into decay." It is, however, a policy open to criticism to suggest, as does the White Paper that the proper way to compensate the railways for increased road competition is to impose a levy on road interests. Such a payment to the railways would amount to a subsidy and if paid at all it should surely be provided by the community as a whole rather than fall upon competing road transport, including "C" licensees. It also seems to us doubtful how far the proposed decentralisation of the railway administration could be carried without damage. Certainly it is wise to provide, as the White Paper policy does, that the Transport Commission should be consulted upon the point. For important economies can be expected to accrue eventually from the standardisation of locomotives, rolling stock, &c., and even from that of operational methods as between the regions. Those advantages should not be lightly sacrificed because the centralisation that alone can bring them about is also deemed to have introduced certain counterbalancing disadvantages.

It will be observed that the policy outlined in the White Paper seems to us open to criticism in certain detailed respects. But the most powerful criticism that can be directed against it is that it does not appear to be a policy that the socialists could bring themselves to accept. It is, indeed, largely a policy of attempting to put the clock back; and Mr. Morrison has already stated that if it is carried out the Labour party, if and when returned to power, will restore the situation. But the worst disaster that could befall transport in this country is that it should become the shuttlecock of party politics. It is more important that the two parties should agree upon a common policy than that either of their ideologies should be fully served. What that policy might be we cannot know. Possibly it might run along the lines of permitting private road concerns to compete with a Road Haulage Executive bereft of its monopolistic powers of compulsory purchase, leaving the Railway Executive undisturbed. The reintroduction thereby of full road/rail competition would, it is true, make the integration of road and rail transport impossible. But, after all, there is very little evidence to show that the Transport Commission is making much progress in co-ordinating either road and rail services or road and rail charges, and "C" licensees are already competing heavily both with nationalised road transport and the railways. There may be several other policies that might prove not too offensive to either party's susceptibilities. We trust one can be found. For we reiterate our view, a view that must be shared by industry in general, that what is important now is not the satisfaction of ideologies but the settlement of a policy for transport that will not be subject to change with every alteration in the colour of the Government. In this matter—as indeed in the matter of the future of the iron and steel industry, too—the interests of the nation should be placed above the conflicting convictions of political parties.

## ANGLO-AMERICAN COUNCIL

ON June 30th, as recorded elsewhere in this issue, the Anglo-American Council on Productivity will cease to exist as an international body. That Council came into being in July, 1948, following upon discussions between Mr. Paul Hoffman, who was then Administrator of the "Marshall" plan, and the late Sir Stafford Cripps. Its close connection with "Marshall" aid was recognised by the Council at its first session in 1948, when it was decided that its term of life should correspond with that of the Economic Co-operation Administration, which was planned to end on June 30, 1952. In effect, as a form of "Marshall" aid, American industry proposed to reveal to British industry the techniques it had developed in high productivity. Those proposals were not at first well received in this country. For neither the value nor the generosity of the idea was at once appreciated, and it was not easy for British engineers and industrialists, proud of their past record, to admit that in productivity, if not in other industrial techniques, this country had been outstripped by America and had anything to learn from that country. But that mood passed as soon as the first report —by a steelfounders' productivity team, led by Mr. F. A. Martin—was published. For that report turned out to be a remarkably interesting document, which showed how deeply the members of the team had been impressed by the enthusiastic attitude of all engaged in American industry towards enhanced productivity and by the evidence of the great material wealth being built up in that country.

Unquestionably the work of highest value performed by the Council during its four years of existence has been the organisation of the visits of productivity teams to the U.S. In all, sixty-six teams have crossed the Atlantic. Forty-nine were drawn from individual industries and seventeen were specialist teams studying particular subjects, such as simplification in industry, packaging, materials handling, &c. Unfortunately, it is not possible to assess at all accurately what influence the visits of those teams to America have had upon productivity in this country. For the measurement of productivity is difficult in itself and the visits took place during a period when much capital was already being spent here on the expansion and re-equipment of industries and when conversion from armaments to peacetime production was still in progress. It can hardly be doubted that the influence has been large. But probably it has been far less direct than the originators of the Council imagined it would be. We doubt, for instance, whether members of teams acquired appreciably more knowledge in America of methods and techniques applicable in their own works than they could have gained by comparable tours of progressive factories on the Continent or even in this country. For industrial conditions in America differ in many respects from those ruling here, and British manufacturers need to find their own solutions for British productivity problems that cannot at all necessarily be solved successfully by the adoption of American methods. The true value of the visits has lain less in the collection of new technical knowledge than in the stimulus to new thought brought about by the contact of executives and men from the shop floor with the "American Way of Life." For the enthusiasm of Americans of all grades for increased productivity and the high degree of productivity ruling in jobbing as well as in mass-production factories proved a revelation to all. Nor has that been the only indirect influence of the visits upon British industry. The Americans proved pleased to open their factories to the British visitors. But it was found also that they were similarly open to visits from direct competitors. Little secrecy is maintained in America about production processes and methods. The discovery of that frankness—combined with experience at home during the war, of the value of spreading knowledge over whole industries—has probably served this country well in tending to break down competitive secrecy in British industry; and it has thereby greatly helped the work of industrial associations and the progress of research into industrial problems. In short, the lasting value of the work of the Anglo-American Council is likely to lie in the psychological influence its work has had within industry in creating a " climate " favourable to the raising of productivity. In addition, through the visits of the teams, personal and industrial links have been formed and a beneficial cross-flow of technical information has been set up across the Atlantic which should benefit the industries of both countries.

As an international body, unique of its kind, the Council is now about to break up. But the need constantly to press British productivity upwards still remains. For the time being the British section of the Council will remain in being to complete publication of productivity team reports ; and a book reviewing the chief features affecting productivity as revealed by the work of the Council and the experiences of the teams is to be published. Thereafter it is hoped, through the co-operation of the Federation of British Industries, the British Employers' Confederation and the Trades Union Congress, to establish jointly a British Productivity Council to carry on the work of furthering increased productivity. The new body is likely to have important work to do. For in the future the maintenance of enthusiasm for enhanced productivity may prove more difficult than in the past. Already heavy taxation is reducing the incentive towards increased output and shortage of raw materials frustrating attempts at higher production. Limitations on capital expenditure prevent the acquisition of new and more productive machinery and plant. Moreover, though it is easy enough to see upon a broad generalisation that standards of life cannot be raised without an increase of productivity per head, the situation is seen in a different light when recessions in trade, such as that which has hit the textile industries, threaten to create unemployment ! A Council representative of labour as well as management and formed to foster and preach the virtues of raised productivity, whatever the economic and industrial climate, is very likely to prove its value in the uncertain future.

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## Obituary

### CHARLES McDERMID

There are many engineers who recall Mr. Charles McDermid's long years of service as secretary of the Institution of Mining and Metallurgy, and of the Institution of Mining Engineers. We have learned with regret of his death which occurred at the age of eighty-four on May 7th, at Bexhill-on-Sea.

Charles McDermid was born in Darlington, and as a young man served as assistant private secretary to the late Sir David Dale, who was chairman of the old North-Eastern Railway company. Subsequently, for a time, he was assistant secretary of the Iron and Steel Institute. Mr. McDermid became secretary of the Institution of Mining and Metallurgy in 1900 and held that office until his retirement in 1939. For several years—from 1920 to 1939, in fact—he was also secretary of the Institution of Mining Engineers. As a fitting acknowledgment of the services which he rendered to those bodies, both Institutions, just prior to his retirement, conferred upon him the distinction of honorary membership.

During his long period as secretary of these two Institutions, Mr. McDermid did much to promote full collaboration between mining institutions throughout the Empire. He took a leading part in the organisation of the first Empire Mining and Metallurgical Congress, which was held in London in 1924. It was followed by the establishment of the Empire Council of Mining and Metallurgical Institutions, of which he was honorary secretary for many years. Mr. McDermid was an honorary member of the American Institute of Mining and Metallurgical Engineers, honorary corresponding member of the Canadian Institute of Mining and Metallurgy, and a Fellow of the Chartered Institute of Secretaries. He was also, from 1931 to 1947, a member of the Governing Body of the Imperial College of Science and Technology.

### JOSEPH JAMES CARTER

We record with deep regret the death of Mr. Joseph James Carter, of 273, Inner Promenade, Fairhaven, Lytham St. Annes, which occurred on May 7th. Mr. Carter was particularly well known in the British oil engine industry, and was vice-chairman of Crossley Brothers, Ltd., and chairman of its subsidiary, Crossley Premier Engines, Ltd.

Mr. Carter joined Crossley Brothers, Ltd., in Manchester, as a boy more than sixty years ago, and from small beginnings made his way to a leading position in the oil engine industry. Throughout his long career Mr. Carter was extremely active, particularly in the years of depression between the two world wars. He was one of those who then took a prominent part in bringing together in co-operation and understanding firms in this country engaged in diesel engine manufacture. That co-operation has continued and led ultimately to the formation of the British Internal Combustion Engine Manufacturers' Association, of which Mr. Carter was a founder member. He was also a past-president of the British Engineers' Association, and had served on the Grand Council of the Federation of British Industries.

For thirty-five years Mr. Carter was managing director of Crossley Brothers, Ltd. He retired from that position in April last year, owing to failing health, but to the end he took a keen interest in the affairs of the business to which he had given so many years of faithful service.

### SIR ROBERT MICKLEM

It is with regret that we have to announce the death of Commander Sir Robert Micklem, C.B.E., in London on Tuesday last, May 13th. Sir Robert, who until a few weeks before his death was joint managing director of Vickers, Ltd., and managing director of Vickers-Armstrongs, Ltd., was born on June 5, 1891. He was educated at the Royal Naval Colleges at Osborne and Dartmouth, and served in the Royal Navy from 1903 till 1919. When he retired from the Navy, Sir Robert joined Centrifugal Separators, Ltd., and in 1923 became a director of British Separators, Ltd., a subsidiary company of Cooke Troughton and Sims, Ltd. Thus there began an association with the Vickers group which lasted until his death. In 1928, Sir Robert was appointed general manager at the Elswick works, and in 1931 he joined the board of Cooke Troughton and Sims, Ltd., of which he became chairman in 1936. During the last war his services were lent to the Government and he was appointed chairman of the Regional Board Northern Area of the Ministry of Production in 1942. He also served as chairman of the Tank Board and chairman of the Armoured Fighting Vehicle Division of the Ministry of Supply from 1942 till 1944.

When Sir Robert concluded his war service he returned to the Vickers group as deputy chairman of Vickers-Armstrongs, Ltd., and some two years later became chairman. In November, 1951, he became joint managing director of Vickers, Ltd., with Sir James Reid Young, the director of finance and administrator of Vickers-Armstrongs, Ltd. In addition to his duties with the Vickers group, Sir Robert was a member of the boards of a number of other concerns, and he had to relinquish all of these posts owing to ill-health in April last.

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## Letters to the Editor

*(We do not hold ourselves responsible for the opinions of our correspondents)*

### DEFECTS IN SPEECH

SIR,—It would be interesting to know why the people concerned with non-destructive testing have generally seen fit to flout the accepted custom of placing the accent on the last syllable of the word defect. A flaw in a structure becomes a "deefect." This a very ugly word and I think if these people would "reeflect" a little they would "reevert" to the conventional pronunciation if only for the sake of euphony.

V. E. PULLIN

London, W.C.2, May 8th.

### PRESENT-DAY LOCOMOTIVE WORKING

SIR,—I was interested in Mr. C. Jolliffe's comment on the "7 MT.s'" shuttling propensities, although these must now be fairly notorious.

Above 55 m.p.h. or so, the theoretical tractive effort curve—the resultant of the torque and inertia curves—exhibits a peak and a trough during each revolution which become more marked with increase of speed. Since the shuttling experienced synchronises with these peaks and troughs, the most economical explanation is that a reciprocating balance of 40 per cent is insufficient to ensure smooth riding of the two leading coaches. In a small number of cases, however, the drawspring characteristics of the first coach suffice to damp the oscillations completely, while they are in all cases damped out by the mass and drawgear of the first two cars.

It is scarcely possible to increase the reciprocating balance, because of hammer-blow, and, therefore, shuttling may well be inherent in the design and not a mere "teething trouble."

There are probably many passengers who do not share Mr. Jolliffe's sensory acuteness, and interpret such boisterous motion purely as satisfying evidence of high speed. Similarly, while attempting written work in a train, I was silently cursing the capers of an old bogie of N.E.R. origin, which hunted perniciously at normal running speeds, when a business man remarked to his colleague, "Quite a nice riding coach, this." Nevertheless, passengers attempting tea would be in a parlous plight, when, for instance, sustained speeds of 80 and more were being run between Shenfield and Colchester, if the restaurant cars were, by an oversight, marshalled at the head of the train.

The designer of a powerful two-cylinder locomotive goes in peril of the horns of a dilemma, for he must punish either the track or the passengers, and both courses are inadvisable. On the other hand, a three or four-cylinder engine without reciprocating balance (e.g., Mr. Bulleid's "Pacifics") is vastly easier on both, and that is one reason why multi-cylinder machines are preferable for fast and heavy passenger duties.

J. D. MUNNION

Chelmsford, May 6th.

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## The British Coal Utilisation Research Association

THE annual report for 1951 of the British Coal Utilisation Research Association has been issued recently. There is a short account of its open day, some notes upon the constitution of the Council, and it is stated that the new building for the Domestic Appliances Division is complete and that its equipment is well advanced, so that the transfer of the Division will begin in 1952. The founding of a Coal Science Lecture is recorded and also that Professor Sir Alfred Egerton had agreed to give the inaugural lecture. A general financial statement is included and the names of the twenty companies admitted to membership during the year are listed, this being followed by a reference to contacts between the Association staff and the member firms, to its publications and to the present state of the library. The research report is presented in three sections and reference numbers are given which relate to relevant papers and reports and which are listed separately. In the Technical Research (Domestic) Division attention has been given to investigating the means of burning bituminous coal smokelessly and the least smoke was obtained with an "invertible" firebox. The problem of increasing the efficiency of domestic heating equipment has been studied and other work has included tests of a stand-in adapter fire, which gave a coal-using efficiency of over 35 per cent.

The boiler, furnace and gas producer departments form the three sections of the report of the Technical Research (Industrial) Division. A study of coal characteristics of low and high-ash coals has been made by the boiler department, and work on the factors affecting heat transfer in boiler smoke tubes has been continued, using straight and special shaped tubes. Several new items have been undertaken and the report mentions work on the causes of the carry-over of wet steam from boilers, the development of an electrical method for measuring the wetness of steam and an evaluation of the effect of refractory furnace tube baffles in shell pattern boilers. The furnace department has continued to study the slagging cyclone combustor for burning high-ash fine coal in gas turbines and to develop industrially the downjet coke burner. Automatic control of the coal feed to gas producers has continued to be under review by the gas producer department, and improvements and refinements made to the combined system. Future work will be concerned with the elimination of variation in gas quality. The outstanding achievement during the year, it is revealed in the report, has been the discovery of a simple process for pelleting slurry so that wet coal slurry from the coal washeries can be used.

The third section of the report comes from the Laboratory Research Division and is presented in four parts covering the work of the combustion, physics, mathematics, and chemistry departments. Three major problems studied by the combustion department relate to the influence of coal characteristics on boiler efficiency, the behaviour of inorganic impurities in coal and the emission of smoke. An investigation into the mode of heat release from the fuel to the gases leaving the bed has been carried out and attention given to the subject of the smokeless burning of bituminous coals, while field investigations have continued in the boiler availability programme.

The physics department reports that work has proceeded on dust sizing and sampling and the grindability of coal. A modified extraction unit for routine dust sampling is briefly described, and it is stated that full-scale trials on a pulverising mill have taken place. An apparatus for the study of the Young's modulus of coals is nearly complete, and it is noted that a suction pyrometer for industrial boilers has been developed. The main function of the mathematics department has been to study design and to analyse experiments for other departments. Coal assay results have been analysed and a "national" formula derived for the mineral matter in coal.

During the year the chemistry department completed an investigation of tar distillates, and work is proceeding on the development of non-fuel uses for coal, including the possible production of carbon black, and on a study of the coal substance. Other items of research include an examination of the mechanisation of the initial formation of boiler deposits and the possibility of the treatment of coal to reduce smoke emission.

The report includes a list of reviews which have appeared in the *Monthly Bulletin*, and of the titles of articles in the *Quarterly Gazette*. Summaries of reports and published papers are given, together with a list of interim reports to technical committees and of patents held by B.C.U.R.A. The various advisory committees are recorded and there is a classified list of member companies.

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## Short Notices

*Building and Civil Engineering Plant*. By Spence Geddes. London: Crosby Lockwood and Son, Ltd., 39, Thurloe Street, S.W.7. Price 30s.—The purchase and use of building and civil engineering plant requires a considerable knowledge of many kinds of machinery. The object of this work is to provide a book of reference on such plant, and to indicate factors concerning its purchase and efficient operation; it is therefore intended for the agent, the site engineer, and the plant engineer, and others concerned with plant and its efficient operation.

The reader is first introduced to some practical considerations involved in purchasing and operating plant, and then to some economic points, related to the unit costs of the work performed. The ensuing sections each relate to a specific type of plant, each giving such details as normal output and apportionment of labour for the plant concerned, as well as descriptive matter about its design. These sections are in alphabetical order and cover the following subjects:—Agricultural plant; air compressors and pneumatic tools; angledozers and bulldozers; asphalt, bituminous macadam and tarmacadam mixing plant; concrete mixing plant; concrete vibrating plant; conveyors; cranes; crushing and screening plant; elevators; excavators; loading shovels; pile driving plant; platform hoists; pumps; rollers; tractors and scrapers; transporting plant, and trenching plant.

Such a comprehensive volume on plant will doubtless be of considerable use as a work of reference. However, it is to be hoped that future editions will be thoroughly revised to include any developments which may take place. Even in this edition, there appear to be some additions which could usefully be made. Two examples which spring to mind are, first, the tower crane, which is now being made in this country to Continental designs, and second, some notes on tunnelling plant, including the so-called "Swedish" drilling methods.

*Quarrying Stone for Construction Projects*, By Ir. H. Streefkerk. The Netherlands. Uitgeverij Waltman, Delft. Price 17·5 guilders. —This book describes current practice in commercial quarries in the U.S.A. and its application to construction projects. It opens with a general chapter defining the terminology of the subject and giving notes on rock structures and suitability, exploratory work for quarries, types of explosives and blasting, and the loading of stone. The second, third and fourth chapters are devoted to the production of stone for concrete aggregates. The use of wagon drills is discussed in Chapter II, including methods of operation, blasting, and so on; Chapter III is concerned with quarrying with large diameter drills, and Chapter IV with the selection of the type of drill. Stone for the construction of breakwaters is the subject of Chapter V. The last chapter gives a brief description of the method called "thermic boring" or "jet piercing."

# Kent Oil Refinery

*The Anglo-Iranian Oil Company, Ltd., is increasing its refining capacity in this country and has under construction the Kent refinery, on the Isle of Grain, lying on the south bank of the Thames at the confluence of the Thames and Medway estuaries. The project will be completed in three stages and phase one, the distillation unit, is expected to come on stream at an initial annual throughput of 2 million tons, which will be raised eventually to 4 million tons when all three phases are complete.*

THE capacity of Great Britain's oil refinery industry will be further expanded when the refinery, which the Anglo-Iranian Oil Company, Ltd., is constructing on the Isle of Grain in Kent, comes on stream later this year. For this purpose the company has registered a subsidiary company, Kent Oil Refinery, Ltd., to operate the Kent refinery. Two other refineries owned by the company are in operation in this country, namely, at Llandarcy in South Wales and at Grangemouth in Scotland. Both are producing at a volume in excess of the rated throughput, which is 3 million tons per annum for Llandarcy and 1·8 million tons for Grangemouth, the actual annual throughput of these refineries being 4 million tons and 2·25 million tons respectively. The coming on stream of the refinery on the Isle of Grain will help not only to raise the refinery capacity of the company in Great Britain but will offset, in part, the capacity lost with the shutting down of the Abadan plant, which is the biggest refinery in the world and had a throughput of 25 million tons per annum. A refinery expansion programme has also been undertaken in Europe in co-operation with associated companies, and the capacity of plants in Belgium, France, Italy and Germany is being increased.

With its other refineries serving the north and the south-west of the country, the south-east was chosen for the site for the third refinery, to enable products to be supplied economically to London and the surrounding districts. An essential requirement was the availability of a suitable approach from the sea and a depth of water sufficient for the berthing of the largest oil tankers. The Isle of Grain, lying some 40 miles from London on the south bank of the Thames at the confluence of the Thames and Medway estuaries, was selected as the site. Much of the area is reclaimed marshland intersected by tidal ditches, lying below the level of high water and of low bearing capacity, but these disadvantages were outweighed by the presence of a sheltered deep water frontage on the south side of the promontory which is bounded by the Medway River. There is a maximum rise and fall of tide of about 17ft and a minimum depth of water of 40ft.

The estate taken over by the company is about 2000 acres in extent, of which approximately 600 acres are being developed for the present project, which is expected to cost £40 million. Work on the site commenced in June, 1950, but since then the original plans for the refinery have been modified to enable the capacity to be increased from 2 million tons per annum to twice that amount. This has been determined by events in Iran which have also accentuated the need for the rapid commissioning of the project for the production of simple base products.

As drawn up the scheme envisaged the completion of the work in three stages, as illustrated in our flow diagram, and it is hoped that phase one, which consists of the installation of a crude distillation plant, having a nominal capacity of 80,000 barrels per day, and the necessary auxiliary plants for the sweetening and blending of the main products such as copper chloride sweetening units, a stabiliser plant and a sulphur dioxide treatment unit, will be operating by July of this year. The initial annual rate of production will be at 2 million tons and this will be increased to 4 million tons by the following year. In the summer of 1953 the second phase is expected to be ready for coming on stream and consists of a vacuum distillation unit of 17,000 barrels per day capacity, a catalytic cracker of 10,000 barrels per day capacity, and a number of minor plants, which include a catalytic polymerisation plant, an acid treater, a re-run unit and a copper chloride sweetening plant. The last phase, expected to be ready by the end of 1953 or early in 1954, will include a second vacuum distillation unit and the building of a lubricating oil refinery which will consist of a propane de-asphalting process, a furfural-extraction unit, an M.E.K. dewaxing plant and a clay-contact unit. Our diagrammatic drawing shows the general lay-out of the Kent refinery, which, when working at full capacity, will process 4 million tons of Middle East crude oil per annum and will produce annually 965,000 tons of motor spirit, 110,000 tons of kerosene, 29,000 tons of tractor vaporising oil, 490,000 tons of gas oil, 1,862,000 tons of fuel oils and 140,000 tons of lubricants.

### SITE PREPARATION

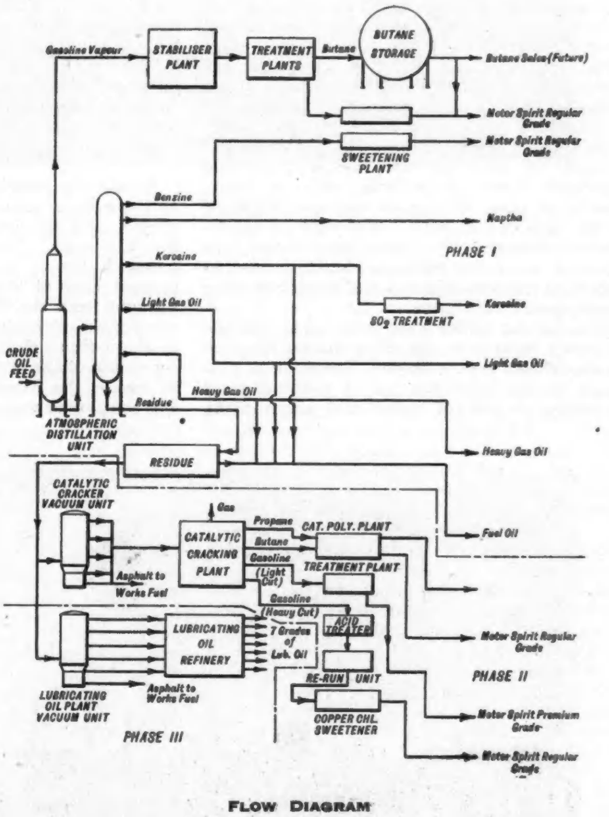
As mentioned previously, the site chosen was low-lying and to a great extent waterlogged so that a great deal of preparatory work had to be carried out before foundations for the various units could be laid. Water had to be drained away and the vast network of ditches, with which the land was intersected, were cleaned out then filled in with gravel soil transferred from the higher ground of the island. This work, together with the filling required for building embankments for roads and railways, preparing tank bases and other earthworks, when completed, will have involved the removal of 2 million cubic yards of material. In addition to this the level of an area of 100 acres, lying at the south-east extremity, has been raised by hydraulically placed sand fill. This has been dredged from a sand bank in the Thames estuary some 6 miles distant and then pumped ashore at the rate of 10,000 cubic yards per day, the sand settling to form a solid level surface and the water draining back to the river.

The storage and fuel oil tanks are not built on piled bases but are founded on the natural marsh. Following upon the filling in of the "fleets," natural earth mounds were formed to a height sufficient to allow the surface of the mound to settle, under load, down to a level just above that of the marsh. This method of construction has meant a careful investigation to establish the commissioning heights for the oil tanks and these have been determined by slow water testing. The water level was raised by fixed increments, at widely spaced time intervals, extending over a period of months, and a record taken of the settlement at each stage and, from a graph of settlement readings plotted to a base of pressure, the commissioning heights were established. By adopting this method of building the tank bases a considerable saving of steel and concrete was effected and the construction costs sensibly reduced.

The varying thickness of the clay and ballast overlying the London clay which obtained over the site, influenced the decision taken with regard to the foundations of the refinery units and a Mackintosh test tool was extensively used prior to determining piling design.

In the area selected for the construction of the topping unit, London clay was close to the surface and for supporting the unit and stack 10in, 12in and 14in precast reinforced concrete piles varying in length from 25ft to 45ft were used. For the catalytic cracking plant vacuum towers and power station, a different technique was followed, the blue clay was excavated and a mass concrete base was laid on the ballast to support the reinforced concrete sub-structure. Lighter units such as the washeries and treatment plants, have foundations generally formed of precast piles, about 25ft to 30ft long, of both plain and prestressed design, while the lubricating oil units have prestressed piles approximately 55ft in length. For certain miscellaneous equipment thin reinforced concrete slab decking has been laid to reduce local bearing pressures.

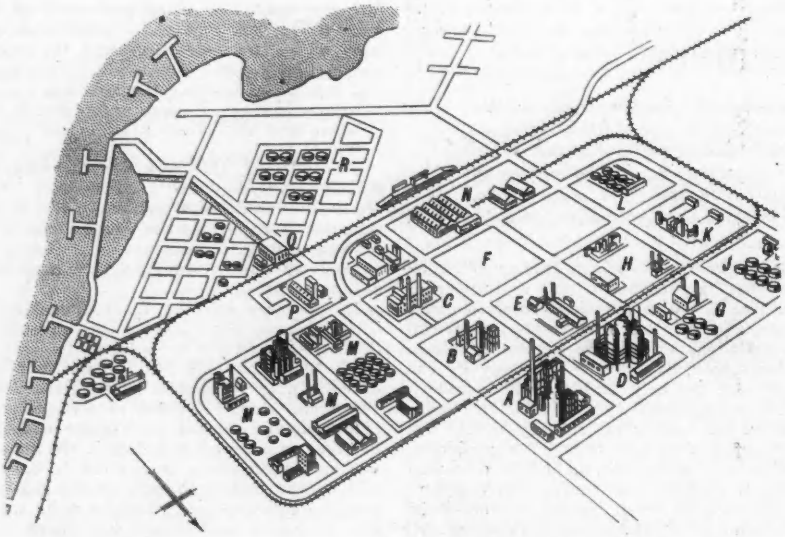
On the foreshore a marine office is to be built on an area which consists of poor ground of low bearing capacity and the problem has been solved by designing the building with a basement foundation so that it displaces its own weight in soil. For the laboratories and main administrative offices Franki piles have been adopted to support the foundations, a decision determined by the variable depth of gravel on the site.



FLOW DIAGRAM

### MARINE TERMINALS

When complete, the refinery will have four new deep water jetties, one of which we illus-



A—Distillation unit
B—Vacuum units
C—Boiler plant and power station
D—Catalytic cracker
E—Stabiliser unit
F—Reformer area
G—Recovered oil unit
H—$SO_2$ plant and re-run unit
J—Black oil and pressure storage
K—Copper chloride treatment plants
L—White oils storage
M—Lubricating oil refinery
N—Workshops and stores
P—Administration building
Q—Cooling water pump house
R—Crude oil storage tank farm

DIAGRAMMATIC LAYOUT OF REFINERY

trate. All the jetties have a minimum depth of water of 40ft so that oil tankers of 32,000 tons capacity can be safely berthed. Measured from the Newlyn Datum the tidal range is from the mean low water springs at 7·70ft below datum to mean high water springs at 8·93ft above datum to give a rise and fall of nearly 17ft. The jetties are spaced 817ft apart and all have "T" heads measuring 230ft long by 35ft wide. The approach roads, which are 15ft wide and capable of carrying a rolling load of 3 tons, have 14ft cantilever pipe track supports on each side. Due to the contour of the coast line the length of the approach roads varies from 240ft to 500ft. Steel box piles, having an average length of 110ft and fitted with reinforced concrete placed after the piles have been driven into position, are being used and double deck construction has been adopted, the bracing decking forming an "A" frame.

Two of the jetties have short necks and the mooring wires from the ships will be taken to bollards sited on the shore. For mooring purposes at the other two jetties, a line of piled dolphins in 30ft of water and about 200ft apart are set approximately 150ft shoreward of the berthing line.

In addition to the loading and unloading facilities, which include hose-handling cranes, the jetties will be equipped for supplying steam to the oil tankers and with the latest fire-fighting appliances. The equipment will include a number of fire mains which will be led to monitor towers, one at each end of the jetty and a separate pipe-line to carry foam from mobile tankers stationed within the refinery area.

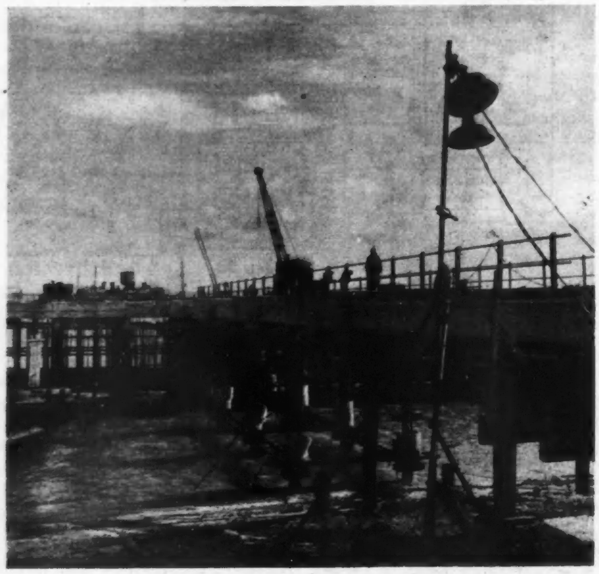
### DISTILLATION FLOW

As already mentioned, the distillation unit and ancillary plants form phase one of the project and will commence initial production in July next. The photograph reproduced herewith shows the distillation unit and a general view of the refinery area. Crude oil brought from the Middle East by units of the company's oil tanker fleet will be transferred in the main to the crude oil storage tank farm by means of the ships' pumps. This operation is within the capabilities of modern tankers, but some older vessels do not have the capacity to pump direct to the final storage tanks so, to assist in the operations, intermediate electrically driven centrifugal crude oil transfer pumps have been installed.

From the tank farm a battery of electrically driven centrifugal pumps will deliver the crude oil to a bank of heat exchangers, where its temperature will be raised to about 330 deg. Fah. by a transfer of heat from the products of the distillation towers. The warmed crude oil will pass to the primary flash column, which is built in two sections having diameters of 18ft 6in and 10ft 6in respectively, and there will be produced an overhead primary flash distillate. This gasoline vapour will be condensed and piped to the stabiliser plant, where the vapour pressure will be reduced by removing gases which are not liquid at atmospheric pressure and temperature. After stabilising the product will pass to the treatment plants, from where the butane will go, as a liquid, to pressure storage in a "Hortonsphere," of 5000 barrel capacity, designed to withstand a maximum pressure of 100 lb per square inch gauge. The straight run gasoline after treatment will pass to a copper chloride sweetening unit, in which a chemical finishing process will remove organic sulphur compounds and other unpleasant vapours.

The bottoms from the primary flash column will be drawn off by pumps and put through the primary and secondary furnaces, which are of the four-pass system and operate in parallel. They can be fired by either gas or oil and each furnace is capable of releasing 150 million B.Th.U.s per hour and of raising the temperature of the bottoms from 450 deg. to 600 deg. Fah. At this temperature the oil will enter the secondary or atmospheric tower, which is about 145ft in height by 22ft diameter, where it will be free to expand and all but the heaviest portions will flash into vapour. The various components of the crude oil have different boiling points and the vapours will rise in the tower to a level at which their temperature falls to that at which each becomes liquid, and they will collect as fractions on trays perforated to take bubble caps.

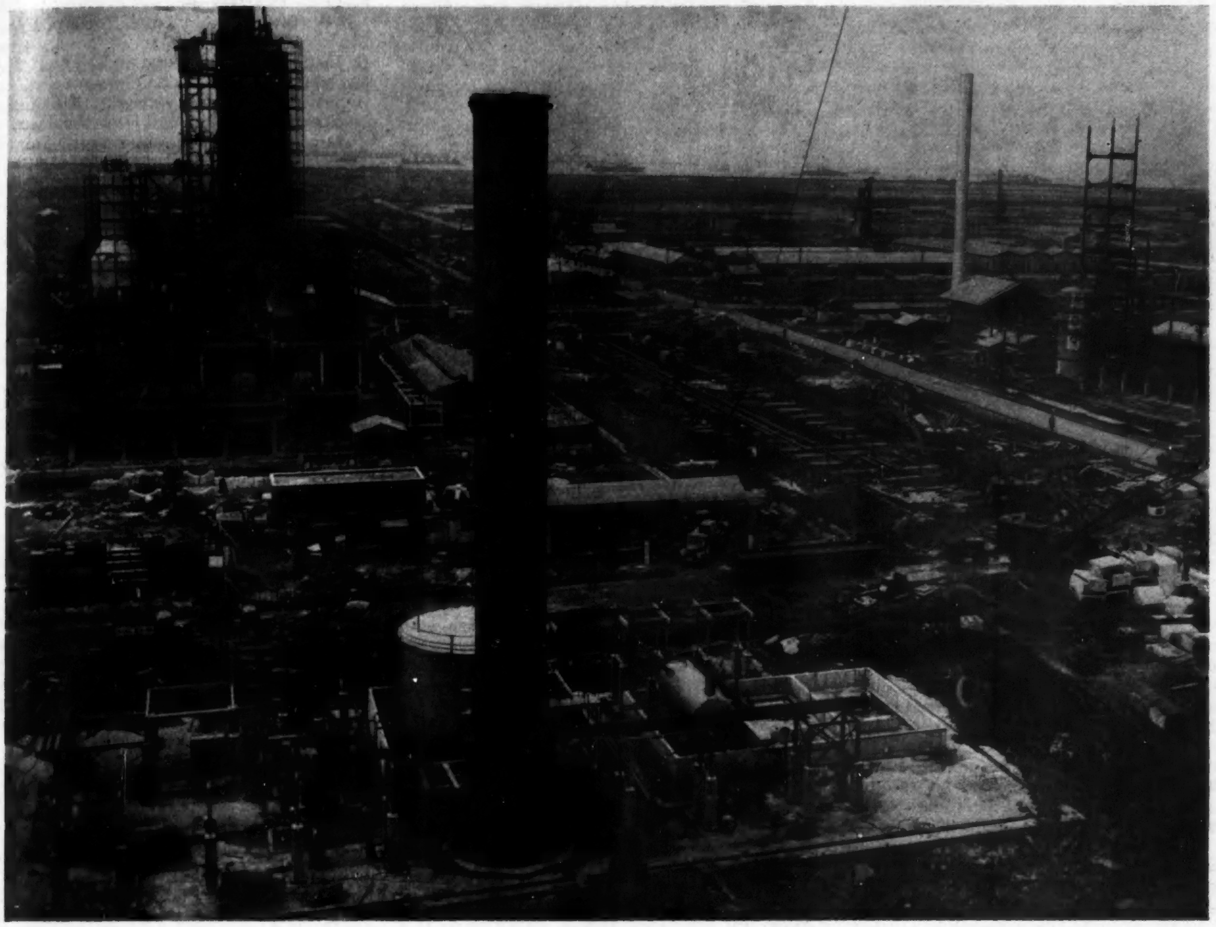
The overhead cut is benzene, which will be condensed and then treated in a copper chloride sweetening plant before being passed to the motor spirit regular grade tanks. At the next level is the liquid side stream cut, naphtha, which will be cooled and forwarded direct to storage. Lower down the column, at a higher temperature, kerosene is collected and this fraction will be pumped to a treatment unit in which sulphur dioxide is used as a medium for making premium grade kerosenes. Light and heavy gas oils are the next side stream cuts and they will be pumped direct to storage. The residue will be stored to form



NO. 2 JETTY

COOLING WATER CHANNEL

# DISTILLATION UNITS AT KENT OIL REFINERY



base stock for the vacuum units, one of which will provide feed stock for the catalytic cracking plant and the other, lubricating oil stock for the lubricating oil refinery. All the side cuts and the residue from the secondary tower before passing to storage will be pumped through the bank of heat exchangers which serve to raise the temperature of the crude oil before it enters the primary flash column.

### AUXILIARY SERVICES

The incoming crude oil and the outgoing finished products will be stored in tanks of welded steel construction, varying in size from 60ft high by 144ft diameter, of 6 million gallons capacity, to 30ft in height by 120ft diameter and smaller. The tanks forming the crude oil storage farm have floating roofs, which reduce fire risk, and the tanks containing non-volatile oils are generally constructed with conical roofs. In addition, the refinery will take over nearly fifty tanks of a distribution depot which previously existed on a site belonging to the Medway Oil and Storage Company, Ltd. The piping network consists of lengths of seamless steel tube, generally 12in and 14in in diameter, flush butt welded and the surface tracks are carried on precast reinforced concrete supports, which raise the pipes about 9in above ground level. Roadways, where they cross the pipe tracks, are carried over by precast concrete bridges.

Power for the initial operating period of the refinery will be provided by 33kV supply lines from the grid system. At a later date the refinery's own power station will take over the main load, although the supply from the grid will be retained on a minimum offtake basis.

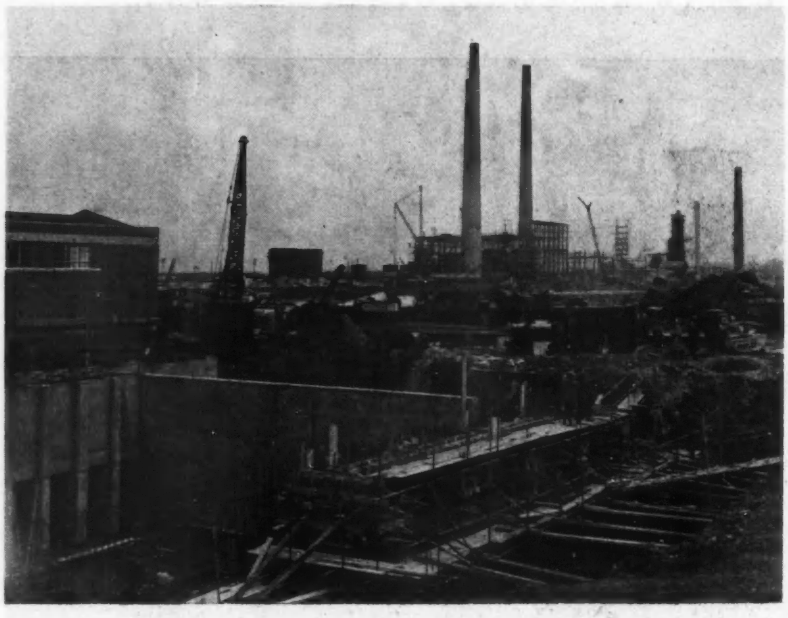
Steam for the various services will be supplied by five spearing three-drum oil and gas-fired boilers, each generating 150,000 lb of steam per hour, at 560 lb per square inch gauge and 750 deg. Fah. at the superheater outlet. Our photograph reproduced on page 674 shows the power station under construction. The boiler feed water comes from external sources and wells and is treated by both lime soda and ion exchange plants.

Four English Electric alternators, two rated at 5000kW and two at 3000kW, driven by back pressure impulse turbines taking superheated steam at 550 lb per square inch gauge and 730 deg. Fah., will meet the electrical load requirements and will operate in parallel with the 11kV grid supply. One turbine of each size will exhaust at 250 lb per square inch gauge to high pressure water evaporators, the condensate being returned as pure feed water for the boilers and the raw treated water being evaporated as process steam at 180 lb per square inch gauge. Some of the exhaust steam will be supplied to the main cooling water pump-house. The remaining pair of turbines will exhaust at 180 lb per square inch gauge to the steam mains for the process and auxiliary plants. When completed the refinery will require 430,000 lb of process steam per hour and an electrical supply of 14,000kW. Power will be distributed at 11kV through a central control station, from which the supply will be by 3300V to substations and thence by 440V distribution cables.

The various process plants and auxiliary services call for an enormous amount of cooling water and the total requirements amount to 4 million gallons per hour. This will be distributed throughout the area at a pressure of 60 lb per square inch by means of four Allen turbine-driven centrifugal pumps, each being a self-contained unit and capable of delivering 1,500,000 gallons per hour against a head of 150ft. To ensure the necessary supply of water a sea wall has been built across a small bight in the foreshore, to form a reservoir and to impound water from the Medway estuary. Two 60in diameter tidal intake pipes, having penstocks fitted to seaward and flap valves on the inside, serve to fill the reservoir. The effective capacity is about 16 million gallons, measured over a tidal range from 5ft above the datum to 3ft below, and this amount is sufficient to satisfy demands for the period between tides with the refinery running at the initial planned throughput. When operating at full capacity the refinery will require about 4 million tons of water on an annual basis, and to meet this demand five electrically driven low-lift vertical spindle pumps will be installed in a sea-water pump-house and jetty situated close to and behind No. 3 jetty. Pumping will take place during low tide periods and the pumps will automatically maintain the reservoir at a predetermined level.

At the entrance to the channel seen under construction in our illustration, which connects the reservoir to the cooling water pump-house forebay, is an emergency regulating structure consisting of sluice gates. The channel, some 4000ft in length, is of trapezoidal section, concrete lined, and measuring approximately 50ft across at ground level, the width of the invert being 15ft while the depth varies from 13ft at the inlet end to 16ft 6in at the outlet. The reservoir serves as a settling tank for the deposition of silt before the water flows to the main refinery circulating pump-house and special water treatment is under consideration to prevent the fouling of the circulating pipes, which if allowed to occur would result in increased resistance against flow and reduce the efficiency of the system.

The effluent cooling water, at a maximum temperature of 110 deg. Fah., is returned to the Medway estuary at a point nearly ¾ mile downstream of the intake, through buried reinforced concrete mains of 88in diameter and lined with steel protected by a "Gunite" cement coating 1½in thick. To reduce the temperature of the effluent and to ensure its return in an uncontaminated condition, the



POWER HOUSE AND PUMP HOUSE FOREBAY

cooling water will be discharged through a battery of separators designed to A.P.I. code. The oil-water separators will consist of a series of steel tanks, measuring 80ft by 40ft, divided into compartments, fitted with baffles and standing on a sand bitumen carpet raised above ground level. The elevation of the tanks ensures that the cooling water will have a gravity flow to the estuary at all states of the tide and the system, which is closed, will operate at a pressure of about 10 lb per square inch.

Most of the design and construction of the project is being carried out by British companies, and the co-ordinating contractor for the work is E. B. Badger and Sons, Ltd. Messrs. Rendel, Palmer and Tritton are acting as civil engineering consultants, while the contractors for the work are Sir Robert McAlpine and Sons and George Wimpey and Co., Ltd. Messrs. Ewbank and Partners, Ltd., are the consultants for the power plant, and Costain-John Brown, Ltd., Matthew Hall and Co., Ltd., and the Motherwell Bridge and Engineering Company, Ltd., are the principal mechanical engineering contractors.

# The Institution of Electrical Engineers

THE annual report of the Council of the Institution of Electrical Engineers for the year 1951–52 was presented at the annual general meeting of the Institution yesterday. The growth of membership was maintained during the session, 2296 members being elected compared with 2431 in the previous year. With a net increase of 695 the total membership during the session was 37,253, of whom 27,753 were corporate members (an increase of 610); the number of graduates increased by 743 to 9,996, while the number of students fell by 667 to 6734. Honorary membership of the Institution was conferred on Sir Arthur P. M. Fleming and on Sir Edward Appleton.

There was an increase in the total number of meetings held at centres and sub-centres, compared with the previous session, but fewer meetings were held in London. Average attendance at the London meetings improved, however, from 267 to 289.

At the fourteen meetings held by the Measurements Section the attendance was 50 per cent higher than in the previous year, thanks, in part, to the conference on Electrical Instrument Design which was held from May 28 to 30, 1951, under the chairmanship of the then president, Sir Archibald Gill. Ten papers were presented and discussed at the four technical sessions, and the total attendance exceeded 700. Apart from this conference, a substantial part of the session programme was devoted to papers dealing with recent developments in automatic control and servo systems. The subject of d.c. amplifiers was again prominent and a group of papers on universal high-speed digital computers read at the November meeting of the section attracted an unusually large attendance.

The radio section, with its membership of 4768, was again the largest of the specialised sections. Eighteen meetings were held, including a symposium of papers on "The World's Highest Powered Television Station, Sutton Coldfield." During the period covered by the report arrangements were completed for a convention on "The British Contribution to Television." The convention itself was held in London from April 28 to May 3, 1952, when more than eighty papers were presented at nine technical sessions after the opening of the convention by the Lord President of the Council, Lord Woolton. A variety of technical visits and social functions were included in the programme.

Meetings of the Supply Section (which has a membership of 3556 and is numerically the second largest of the specialised sections) continued to be well supported. There were eight section meetings, including the annual lecture given by the late Sir Edward MacColl on "Hydro-Electric Power Development in Scotland."

A membership figure of 3548 during the session gave the Utilization Section a marked increase in strength, and there was a corresponding rise in the average attendance figures, from 104 to 121. Of the eight meetings held one was devoted to students' papers. The annual lecture was given by Dr. H. G. Taylor, who discussed modern developments in electric welding.

Most of the fourteen student sections report that support for their activities has been well maintained, but in a few of the sections there has been a falling off in attendance at the meetings. Twenty students attended the summer tour held in France from June 30th to July 15th. The programme, which had been arranged by Monsieur M. Laborde, of Electricité de France, in collaboration with the Office du Tourisme Universitaire, included visits to Paris (Laboratoire Central des Industries Electriques, Centre d'Essais de Fontenay d'Electricité de France, L'Ecole Supérieure d'Electricité, and Paris–Dijon electric traction system), Chartres, Poitiers, Clermont-Ferrand, Lyons (factories and laboratories of Cables de Lyon and Le Musée Ampère), Grenoble (L'Institut Polytechnique and Neyrpric hydro-electric laboratory), Aix-les-Bains, Génissiat (hydro-electric power station of the Compagnie Nationale du Rhône), and Fontainebleau.

As part of the programme of the Joint Engineering Conference (June 4 to 15, 1951), the I.E.E. arranged a garden party which was held at St. John's Lodge, Regent's Park, on June 6th. The conference, which coincided with the Festival of Britain, recorded the contributions made by British engineers, during the past 100 years, to the advancement of civilisation. It was attended by some 1500 delegates and their ladies. Technical sessions were held each morning simultaneously in the lecture theatres of the three Institutions, covering the civil, mechanical and electrical aspects of such subjects as power engineering, sea transport, railways and aviation, and a day was devoted to a discussion of the education and training of engineers. In addition, each Institution had invited papers on its more specialised subjects—water supply, mining, road transport, electrical measurements, television, &c.

The second meeting of the Conference of Engineering Institutions of Western Europe and the United States of America (EUSEC) was held at The Hague in September, 1951. Among other matters the subject of engineering education was discussed, and it was decided to convene a round table conference in England early in 1953 when three representatives of each member society will exchange views on the methods used in each country.

### TECHNICAL INVESTIGATIONS

An abridged edition of the twelfth edition of the *Regulations for the Electrical Equipment of Buildings* was published in November, 1951, for the benefit of interested persons engaged in work on site. The president, with the council, responded to a further request from the Postmaster General made under the Wireless Telegraphy Act, 1949, and added eight names to the panel of experts and interested persons described in Section 9 of the Act. From this panel the Postmaster General has appointed another advisory committee, in this case to deal with questions of the abatement of radio interference caused by small motors. As with the two previous advisory committees, the secretariat is provided jointly by the Post Office and the Institution.

The council has decided to encourage the use of the rationalised M.K.S. system of units, but has directed that, for the present, questions set in Institution examinations should not necessitate a knowledge of the system by the candidate.

The joint committee on model forms of general conditions of contract has completed a short form of the existing General Conditions of Contract "A," suitable for home contracts which involve mechanical, but not site, engineering erection.

At the request of the Ministry of Supply and the Federation of British Industries, the council has co-operated in investigating the subject of international forms of contract for heavy engineering equipment by nominating a member of the Institution to a working party which is to report to the Economic Commission for Europe.

### EDUCATION

The development of technological education has continued to be one of the principal matters considered by the education and training committee, particularly since the publication of the White Paper (Cmd. 8357) on the subject in September, 1951. The council supports the view that there is an urgent need to increase the number of qualified engineers and technologists educated at the universities and the technical colleges; but it does not consider that the proposals of the White Paper, which relates to developments in the colleges, will achieve the desired results. The council considers that the universities and technical colleges have complementary though separate functions to fulfil in helping to meet the deficiencies of technological man-power, and in its opinion the further contribution required of the technical colleges can best be made by the development of a small number as "Royal Colleges of Technology," much on the lines advocated by Lord Eustace Percy in the report (1945) which commonly bears his name. In its deliberations on the subject, the council has kept in close touch with the councils of the Institution of Civil Engineers and of the Institution of Mechanical Engineers, whose views are in keeping with its own.

The council has continued its encouragement of works-based (or, as otherwise known, industry-based) sandwich courses, and has been pleased to learn of the success which attends the first of these courses to be established three years ago. It has also encouraged the establishment of "block release" National Certificate courses to meet the needs of those apprentices and trainees for whom day release under normal part-time arrangements is not really practicable. These courses comprise alternate periods of one or two weeks at a technical college, followed by three to six weeks of industrial training.

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## Transport Policy*

### ROAD HAULAGE

ROAD haulage has in the past been restricted largely in order to avoid excessive competition between road and rail. This process has now gone so far as to deprive trade and industry of the full advantages of modern road transport and has driven traders to provide their own road transport to an extent which would not otherwise have occurred.

The Government are convinced that the undertaking of the Road Haulage Executive set up under the Transport Act should revert to private enterprise. For this purpose it is proposed that the undertaking should be divided into operable units (including a suitable proportion of small units) and be offered to the public for disposal by open tender. Units acquired will be given "A" carriers' licences under the Road and Rail Traffic Act, 1933, and will at once be freed from the 25-mile limit imposed under the Transport Act. Eventually, this limit will be removed from all vehicles, and in the interim period the existing permit system will be continued.

In order to allow road haulage to play its appropriate and expanding part in the transport system, provision will be made for greater latitude in the granting of new licences under the Road and Rail Traffic Act, 1933, where need for a fuller or more convenient service is shown.

Since the goodwill of the former businesses out of which the Road Haulage Executive was formed has substantially disappeared, its undertaking is unlikely to be sold at the price at which it was bought. On the other hand, the units to be marketed will be going concerns and purchasers can be expected to pay for the trading rights and opportunities which go with them.

### THE RAILWAYS

The railways are a national asset. They must remain an essential element in transport, and cannot be allowed to fall into decay. The present excessive centralisation of the railways must, however, be reduced by giving greater autonomy to areas which may follow the general pattern of the present regions. Scotland will be a separate area. The areas will together continue to constitute a single entity for financial purposes and for the control of charges.

The existence of these separate areas should encourage a healthy rivalry between them, and give greater scope for initiative than is possible under a single centralised administration.

It is not intended that the area organisation should be set out in detail in the Bill. It will be dealt with in a scheme which the Commission will be required to submit to the Minister of Transport for his approval.

The Commission will be given greater latitude to vary their charges schemes so as to improve the ability of the railways to compete with other forms of transport. Within prescribed limits they will be free to raise or lower their charges with subsequent approval by the Transport Tribunal and subject to the overriding powers of the Minister.

### LEVY ON ROAD TRANSPORT

These proposals will affect the finances of the Commission in two ways. First, the sale of the Road Haulage Executive's undertaking is likely to involve the Commission in some loss. Secondly, the expansion of road haulage will no doubt result in some further transfer of traffic from rail to road which cannot be offset by countervailing economies in railway operation, including the closing down of redundant capacity. The Government propose that compensation for the losses arising from these two causes should be provided by means of a levy on goods vehicles, including those of "C" licences. A large proportion of the goods now carried by road is carried under "C" licences, and the holders of those licences could not reasonably expect to be exempt from a levy applying to road hauliers. The levy will not, however, extend to small local delivery vans operated under "C" licences.

This levy will be designed to yield initially an annual sum of £4 millions. This sum will enable the loss on the disposal of the Road Haulage Executive's undertaking to be amortised over a period of years and will also include some provision for loss of railway revenue arising from further transfer of traffic to the roads. The extent of these losses cannot, however, be measured until the changes authorised by the Bill have taken effect. The levy, therefore, while it will be limited exclusively to these purposes, will be adjusted at intervals, say, of three years, by the Minister of Transport after consultation with the Transport Tribunal. When the loss from the disposal of the Road Haulage Executive's undertaking is known, one element in the levy will be definitely ascertainable and the period for amortising that loss can then be determined. The remaining element in the levy need be increased only to the extent that the roads attract additional traffic, and therefore additional earnings, from the railways. Thus, the levy will never impose an excessive burden upon road transport and, in view of the large number of vehicles concerned, its incidence on any particular operator will not in any event be heavy. It will be confined to the purposes stated above and will not be used for other purposes, e.g., to make good loss of railway revenues due to a recession in trade or a failure on the part of the railways to secure reasonable economies.

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[*] Extracts from a White Paper under this title issued by the Government on May 8th.

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## Silver Jubilee of Birlec, Ltd.

THIS year marks the Silver Jubilee of Birlec, Ltd., Tyburn Road, Birmingham, 24. Twenty-five years ago Birmingham Electric Furnaces, Ltd., as it was known until just after the war, was founded to exploit a new use for nickel alloys, the raw material of resistance elements for electric furnaces. The original company was part of Henry Wiggin and Co., Ltd., and both these companies are now sister firms within the Mond Nickel and International Nickel organisations.

Within twenty-five years the output of Birlec industrial electric furnaces has grown to such an extent that Birlec, Ltd., now claims to be the largest organisation of its kind engaged exclusively in building furnaces and allied equipment.

The new firm began operations in modest premises, comprising two offices, a store-room and a small assembly shop for the smaller components. These premises, in George Street, off the Parade, Birmingham, had previously been used by Henry Wiggin and Company as a cutlery stamping shop and offices. On the first payroll of the company there were only four names—A. Glynne Lobley, who was, until his death in January, 1950, head of the firm; George P. Tinker, now managing director; T. G. Tanner, now technical director, and E. Rawes, now secretary to the company.

To-day the Birlec works cover most of a $3\frac{1}{4}$ acre site in Tyburn Road and development plans are complete for the small area still vacant. Although the site appeared adequate in 1930, the pressure for expansion was so great even before the war, that a concrete platform was built across the Birmingham Fazeley canal to form the floor of the largest bay in the works. About half a mile from the main works, at 95, Tyburn Road, is the Birlec Heat Treatment Division, where heat treatment is carried out on a commercial basis. In all, the company which began with a staff of four now employs nearly 800 people.

For the first twenty-three years the growth of the company was very closely linked with the work of A. Glynne Lobley, who, as a metallurgist and scientist, was responsible for many pioneering designs. They include the rotary drum annealing furnace, of which more than 200 were produced during the war, when they were used for annealing cartridge cases. Another design was that of the duplex nitrides for aircraft engine crankshafts and liners. A third design was the malleable annealing furnace, an example of which was going through the shops when we toured the works during a Press visit last week.

Among the new heating applications introduced by Birlec, Ltd., in this country are continuous furnace copper brazing, continuous bright annealing, and gas carburising. The company has specialised in the metallurgical problems associated with the use of gaseous atmospheres, and the mechanical problems of evolving various designs of continuous conveyor systems.

One departure from the firm's original functions is the manufacture of gas-fired equipment, which embody a large quantity of nickel alloys, without depending on their electrical resistance for the generation of heat. Another departure has been the entry into the field of melting, using design based on the products of the company's American associates. Beginning with the indirect arc furnace, Birlec, Ltd., extended their activities to the manufacture of the direct arc equipment and the first direct arc unit was delivered in six weeks, just before the outbreak of war in 1939. More recently in company with the Ajax-Norton organisation, the British firm has built high-frequency induction furnaces for steel melting and low-frequency induction units for aluminium and other non-ferrous alloys.

An important Birlec product apart from furnaces is equipment for drying, based on the moisture adsorbing properties of activated alumina. Such equipments, known as "Lectrodryers," originated as means of drying the atmosphere in bright annealing furnaces. From this metallurgical application a large variety of uses have emerged in chemical and general engineering industries.

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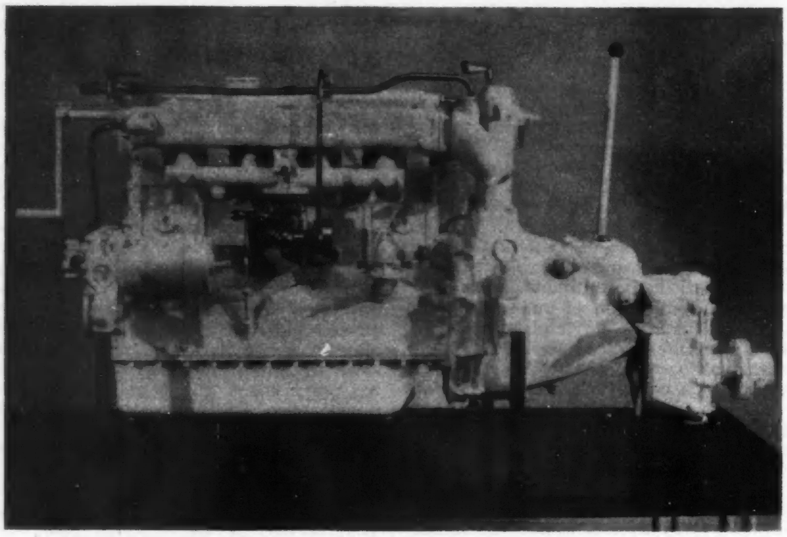
BONDING CONCRETE SURFACES.—The use of rubber latex and cement adhesive in the building industry was discussed by Mr. L. H. Griffiths, M.Sc., F.R.I.C., technical manager of Semtex, Ltd., in a paper read recently at the annual conference of the Society of Chemical Industry. Its ability to bond concrete, he said, had been developed in the building field in improving the adhesion of screeds to base concrete. If a new screed had to be put on to an old base, the old surface had to be thoroughly hacked and broken to receive the new screeding. This hacking and breaking was very costly and in some cases was almost out of the question. Because the rubber latex and cement adhesive itself contained cement, it bonded to the base quite readily and applications were now being developed whereby the screed was applied over the base concrete while the cement and latex adhesive was still wet. Adhesion was thus promoted between the old concrete and the new, which, Mr. Griffiths stated, was an inexpensive and satisfactory method. In building work these adhesives were also finding uses in fixing ceramic tiles and in covering a wall with a sprayed cement or similar material.

# Marine Engine for Small Craft

At the 1951 Motor Show Morris Motors, Ltd., briefly announced the production of the Morris "Commodore" Mark III marine engine, and now the company has supplied a specification giving technical details of the new engine.

The four-stroke, six-cylinder, in-line engine has a bore of 88mm by a 115mm stroke, giving a capacity of 4196·7 cubic centimetres, and has a detachable cylinder head and sump. A "Solex" horizontal pattern carburettor is fitted, complete with flame trap, and is adapted for bi-fuel operation. When operating on petrol the engine has a power range of 30 to 60 b.h.p. and a compression ratio of 6·4 to 1, while the corresponding figures when burning vaporising oil are 27 to 55 b.h.p. and 4·6 to 1. The engine has a speed range from 450 r.p.m. to 2500 r.p.m. and, when fitted with electric starting and a 2 to 1 reduction and reverse gear, the weight is 1196 lb.



"COMMODORE" MARK III MARINE ENGINE

Cast iron is the material used for the sump, which incorporates an oil level indicator specially graduated to take account of the engine installation angle. The cylinder block is of monobloc construction in hard close-grained grey iron, and the die-cast aluminium alloy pistons are fitted with four rings, the topmost one being chromium-plated. Case-hardened steel gudgeon pins are clipped on the small end of the H-section connecting-rod, which is of drop-forged steel and balanced for weight, and the crankshaft, which is a steel forging, is balanced both statically and dynamically and carried in four steel-backed white-metal renewable shell bearings. There is a cast iron flywheel, with junk ring, and it is machined all over to ensure accurate balance.

The overhead inlet and exhaust valves, of silicon-chrome steel, are push-rod operated through replaceable pattern cast iron guides from a five-bearing camshaft having hardened cams and journals. The tappets, which are hollow chill cast, are ground and lapped to a mirror finish and the exhaust valves have seat inserts. For the petrol engine the water-cooled exhaust manifold consists of a one-piece iron casting with hot spot embodied, while for the vaporising oil engine there is a one-piece iron casting, including an exhaust-heated induction manifold and a water-cooled exhaust mixing chamber.

For cooling the engine an open sea-water circuit can be provided or a thermostatically controlled closed fresh water system, complete with heat exchanger. A three-way tap on the cylinder head allows the water to be discharged directly overboard or through an exhaust mixing chamber. In the closed cooling system the fresh water is circulated by a centrifugal pump, and in the sea-water circuit zinc electrodes are fitted as an anti-corrosion measure. The heat exchanger also serves to cool the engine lubricating oil. Lubrication of the main, big-end and camshaft bearings is by a gear pump, while the pistons and cylinders are splash lubricated and automatic lubrication of the reverse gear from the engine is provided. Separate lubrication is arranged for the reduction gear and, for draining oil from the sump, there is a hand pump. Starting is by hand or by a 12V electric starter motor, and there is a 12V dynamo having an enclosed chain drive, while for ignition purposes a vertical magneto is provided and suppressors fitted to eliminate wireless interference.

A clutch of alternate steel and bronze plates provides the ahead drive, and the reverse gear, which is of planetary design, is actuated by means of contracting brake shoes. The unit runs in an oil bath which is automatically maintained at the correct level, and the single control lever is self-locking in both the "ahead" or "astern" positions. According to the rotation required, the speed reduction is effected through a triplex chain drive or double helical gears, and the shafts, which run on ball bearings, are at 5·363in centres. A complete flange coupling for a propeller shaft of 1¼in diameter is supplied and the propeller thrust in either direction is taken by a large ball bearing. The unit is designed for a maximum rake of 10 deg. with the boat under way.

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# X-Ray Camera Unit

The need for economy in the use of X-ray films in British hospitals without restricting the number of X examinations is emphasised by the shortage of film and its high cost. To meet this need Watson and Sons (Electro-Medical), Ltd., Parker Street, Kingsway, London, W.C.2., has designed a new X-ray camera unit which allows substantial savings to be made in the amount of film used for each examination.

The camera makes use of the indirect method of radiography, in which the image on a fluorescent screen is photographed on 4in by 5in cut film, which, when processed, can be viewed on an ordinary illuminator without magnification. This not only saves some 90 per cent in film costs, but also results in economies in developing and storage.

The diagnostic quality of the small films is high, but the system is not intended to displace the use of full-sized films for the final diagnosis for thoracic conditions. It is, however, believed to be more than adequate for "follow-up" records, the examination of T.B. "contacts," and for many other purposes where the patient is examined in an erect position.

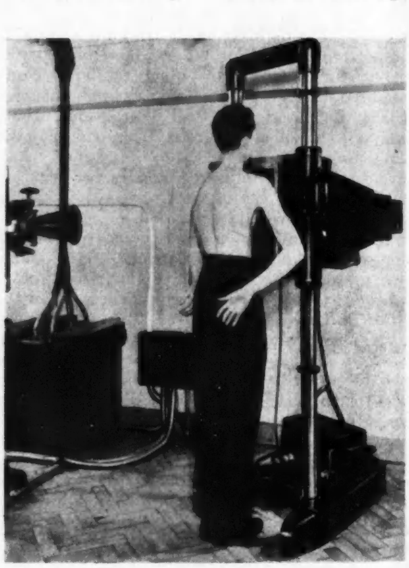
The camera stand is intended for use in conjunction with any standard X-ray generator which has an output of not less than 200mA and with any X-ray tube that is supported on a conventional form of stand.

A light-tight tunnel, which has at one end a 15in by 17in "blue" fluorescent screen and at the other the camera, is mounted on a carriage that is free to move in the vertical direction on a pair of columns which carry counterweights. In front of the screen is mounted a 6 : 1 ratio "Lucidex" grid, to increase the radiographic contrast. Mounted on the camera tunnel is an identification device for recording the patient's name or a serial number, and these details may be written on a card 4in by 6in, of the same form as the standard mass miniature radiography card. Electrical contacts in the camera ensure that an exposure cannot be made until the card has been inserted correctly. Permanent details such as the name of the hospital or the date may be included on the film by means of lead markers which are permanently attached to the front of the fluorescent screen.

A photo-electric exposure timer is fitted to the camera tunnel and automatically ends the exposure when a predetermined amount of radiation has reached the film, which ensures a uniform blackening of the film in the radiography of normal subjects. The timer operates by integrating the light flux emitted by the fluorescent screen. The apparatus can be rapidly and accurately centred with the X-ray tube, and the unit can be tracked relative to the tube stand.

A diaphragm slide is provided for use with a standard Watson tube stand, which ensures that the X-ray beam conforms accurately to the confines of the screen at a 36in focus, for 4in by 5in films. For large screen work a second diaphragm is used, which limits the beam to cover a 14in by 17in film at a focus of 60in.

The camera embodies a specially developed fluoride coated long focus lens, and is of rigid construction, being made from three light-alloy castings, one of which has a micrometer focusing mount and carries the lens.



X-RAY CAMERA UNIT

The lens produces an image (3·675in by 4·1in) of the fluorescent 15in by 17in screens, on the 4in by 5in film. Each film is held in an individual slide which fits into a recess in the back casing of the camera. These slides are of special design and hold the film flat and accurately in the focal plane of the lens. Twenty slides are provided with the standard apparatus.

The equipment may be used for taking large-size radiographs and for this purpose a cassette tunnel can be supplied for attachment to the front of the unit. Means are provided for placing the cassettes in the central or apical area.

# Iron and Steel Institute

No. II—*(Continued from page 635, May 9th)*

AT the afternoon session of the first day of the annual meeting, in London, of the Iron and Steel Institute—Wednesday, April 30th—the following papers were discussed :—

## COLD ROLLING WITH STRIP TENSION: PART I. — A NEW APPROXIMATE METHOD OF CALCULATION AND A COMPARISON WITH OTHER METHODS

By H. **Ford**, D.Sc. (Eng.), M.I.Mech.E., F. **Ellis**, B.Sc. (Eng.), and D. R. **Bland**, M.A.

### Synopsis

It is shown that, by making certain approximations to Orowan's general theory of rolling, it is possible to calculate roll force and torque by a method which is both rapid and easy to apply, using the basic information on the yield-stress characteristic of the material to be rolled, the coefficient of friction, and the dimensions of the pass.

The roll force and roll torque functions used in the calculations are presented in graphical form, the particular values required being read off from the curves in terms of the pass dimensions. Various methods of calculating these quantities for strip rolling with tensions have previously been put forward, and this paper examines the methods of Orowan, Hill, Siebel, Tselikov, and Nádai, and compares them with the new method for a wide range of tensions. The new method can be more quickly applied than any of the other methods examined.

## THE EFFECT OF TENSION ON TORQUE AND ROLL FORCE IN COLD STRIP ROLLING

By W. C. F. **Hessenberg**, F.I.M., and R. B. **Sims**, A.M.I.Mech.E.

### Synopsis

The rolling of mild steel strip with front and back tension has been studied on the B.I.S.R.A. experimental rolling mill, to determine the effect of tension on the roll force and torque and, if possible, to suggest quantitative relationships between these variables.

Simple approximate formulæ for calculating the effect of tension on roll force and torque are proposed, and comparison is made between calculated and experimental results. The difficulties inherent in more elaborate methods of calculation are discussed.

The energy of rolling is composed of the energy required to deform the strip and the energy absorbed in overcoming friction between the strip and the rolls. Since the former depends only on the properties of the strip and the amount by which it is deformed, any effect of tension on the energy of rolling must arise from changes in the frictional component. In most cases this component is relatively small, and the experimental results confirm that the total energy of rolling is, for all practical purposes, unaffected by the application of tension.

## PRESSURE DISTRIBUTION BETWEEN STOCK AND ROLLS IN HOT AND COLD FLAT ROLLING

By C. L. **Smith**, Ph.D., F. H. **Scott**, Ph.D., B.Met., and W. **Sylwestrowicz**, Dipl. Ing.

### Synopsis

A method of measuring the pressure distribution over the area of contact between the roll and rolled stock is described. In this method a photoelastic dynamometer, inside the lower roll, measures the normal force exerted on a small radial pin inset into the roll, the surface of the pin being flush with the roll surface. Devices for applying back tension to the rolled strip, and for measuring the back tension and the total force separating the rolls, are also described. Results are given for the cold rolling of annealed copper strip, 2mm thick by 40mm wide, for reductions from 5 to 50 per cent, and for similar hot-rolled copper strips with reductions of 18, 26 and 36 per cent. These results are compared with results calculated by Orowan's method. The values of the yield stress of copper, measured over the area of contact, are discussed, as is the method of measuring the coefficient of friction between the roll and rolled stock.

## SOFTENING OF METALS DURING COLD WORKING

By N. H. **Polakowski**, Dipl. Ing.

### Synopsis

Steels and non-ferrous metals initially overstrained by tension, torsion, or drawing were progressively compressed in a direction opposite to that of the initial flow. In each case not only was a Bauschinger effect observed, but also an initial gradual decrease of the indentation hardness (by amounts up to 10 per cent) before it increased. Both effects were reproducible and were more pronounced in the higher carbon steels.

A theory relating indentation hardness and the energy stored in a cold-worked metal is put forward as a tentative explanation of both the Bauschinger effect and work softening. To satisfy this theory quenched and tempered steel should soften during the early stages of cold working, and they are shown experimentally to do so.

This energy concept accounts for the low rate of work hardening during reversed and cross rolling of sheets, reversed deep drawing, and during cold working and fatigue testing of heat-treated, i.e., sorbitic and troostitic, steels. The softening effect provides an explanation of the recrystallisation and mechanical properties of single and polycrystalline metals after reversed deformation.

Professor H. Ford, who presented the first paper, said that it represented Part I of a report which was in three parts. The other two had been submitted to the Institute but not yet published. It was not easy to deal with Part I in isolation, and therefore in his introductory remarks he proposed to make some reference to the two subsequent parts.

Mr. W. C. F. Hessenberg (B.I.S.R.A.) presented the second paper, Dr. C. L. Smith (University of Cambridge) the third, and Mr. N. H. Polakowski the fourth.

### Discussion

Mr. W. C. F. Hessenberg (B.I.S.R.A.): I should like to say a few words on Mr. Polakowski's paper. I feel that he has been rather too precipitate in trying to discover an explanation for what he has found by a review of other people's work and by his own experiments, and in particular he has fallen for one of those deplorable spring-and-dashpot models which I think should be banned from metallurgy altogether; they lead easily to absurdities. Mr. Polakowski had a spring operating with a frictional slider, and that was supposed to represent a metal which shows work hardening. The "soft" yield stress was the force required to move the slider and, as the force rose, that was represented by the energy stored in the spring. A piece of copper of 1 square inch cross section has a yield stress to start with of 10 tons per square inch, so that you would require 10 tons to shift it, and by the time you had fully work hardened it you would have 30 tons, with 20 tons in the spring, and when the load was taken off it would stretch like a piece of rubber, which in fact it does not do. Even on the qualitative side the model does not fit well, because the yield stress of a metal is concave to the strain axis, which implies that the strain in his model must weaken as it is compressed or stretched, because for each increment of stress there is a bigger increment of strain. When you reverse it and get the spring helping you to compress the metal the curve should be convex to the strain axis, and in fact it is not; as he shows, it is concave.

I think that the biggest complaint which I have against these models—which can be made to work if you put enough dashpots and springs on them—is that they add nothing to our knowledge; they simulate the behaviour of the metal, but do not tell you more about it. If you want to understand the behaviour of a metal, you have to think of it in terms of happenings on the microscopic scale. In the dislocation theory of metals, work hardening is considered to be due to the gradual piling up of dislocations behind various obstacles such as crystal or crystallite boundaries, or the interference of dislocations with one another as they multiply; the number of them increases as plastic deformation takes place. After we have strained the metal a certain amount, a fair proportion of the dislocations are all packed up behind some obstacle. If we change the stress system they will move off in some other direction and evade those obstacles, and travel some way before finding a new set, so that the Bauschinger effect is what one would expect in a metal with dislocations. It is even the case that in an ordinary tensile test, if we perform it halfway and take off the load, we cause the metal to yield on reloading before we reach the stress which we let go. That negative Bauschinger effect is quite large, as anyone who has done interrupted tensile tests will confirm, and that may be due to the fact that as we unload it we alter the patterns of dislocations, and on reloading some of them may find their way round the obstacles which formerly impeded their progress. When it comes to heat-treatment, the plain fact of the matter is that if you heat-treat some metals they get softer by recovery, while if you heat-treat others they get harder. The only satisfactory explanation of that has again been given in terms of dislocation theory.

Dr. D. V. Wilson (Department of Industrial Metallurgy, Birmingham University): Mr. Polakowski has shown that the Bauschinger effect and the related "work-softening" effects are general properties of cold-worked metals, which may be of considerable practical importance. He does not discuss the influence of metallic structure in any detail, however, although it is clear that this will affect the possible magnitude of the effects which he describes. The Bauschinger effect is generally considered to arise as a result of the inhomogeneous character of plastic deformation. The pattern of the plastic inhomogeneities and that of the consequent internal stress system may vary very widely, both in scale and intensity, with the material and with the method of working.

In polyphase alloys, such as steel, the hard particles of the secondary phase may provide effective local barriers to the process of slip in the matrix. It is easy to see that a system of textural stresses will develop during deformation between the hard particles and the relatively soft matrix, as a result of plastic deformation. The level which such microscopic internal stresses may reach is less clear and will depend on the properties of the particles themselves and the interface between the particles and the matrix, and also on how far yielding of the matrix may be constrained in the neighbourhood of the particles. Some experiments which I have made on steel suggest that, as one might expect, the finer the carbide particle size in a given steel the higher is the level of the internal stresses which may be locked up in the cold-worked material. Moreover, it appears that in the case of a cold-worked steel of fine microstructure the residual strain in the cementite particles may reach very high values, probably in excess of 1 per cent mean strain.

Using a high-carbon steel, it is possible to obtain X-ray diffraction evidence of the balanced residual stress system which is set up between the cementite particles and the ferrite during cold working as a result of their different plastic properties. These microscopic internal strains are, of course, oriented with respect to the direction of working. It is interesting to find that, so far as may be judged from the X-ray results, when a cold-worked specimen is subjected to reversed straining the minimum indentation hardness occurs after a degree of reversed straining which is of the same order of magnitude as that required to eliminate the directional component of this interphase stress system. It is also interesting that, in contrast to the behaviour of long-range or " body " stresses, quite large reversed plastic strains (10 per cent to 20 per cent reduction) appear to be required to eliminate the directional short-range textural stresses. I think that this must be explained in terms of a dislocation picture, as Mr. Hessenberg has suggested. One can imagine that dislocations of like sign are built up against some form of barrier to plastic flow.

Incidentally, on reheating a cold-worked high-carbon steel the interphase textural stresses are not fully relaxed until the steel reaches temperatures significantly higher than 400 deg. Cent. One would not expect, therefore, that Bauschinger effects arising from this cause would be eliminated by low-temperature reheating, as Mr. Polakowski has demonstrated. I am interested in the " work-softening " effects shown by sorbitic steels, to which Mr. Polakowski refers. In such materials a reduction in indentation hardness occurs as a result of moderate degrees of plastic deformation without the necessity of prior cold working.

Professor H. O'Neill (University College, Swansea): I think that Mr. Polakowski has made a discovery. I am very glad that the two members who have so far discussed his paper have not demolished anything more than the dashpots. If we had asked any metallurgist a year or two ago " Do you believe that cold working a metal will soften it ? " he would have said " No, I do not believe it," yet apparently there are members here, and I am one of them, who believe now that in certain circumstances there is evidence that a cold-worked metal can be softened by more cold work.

The point which worries me a little about this phenomenon is the effect which it has upon the mechanics of hardness testing itself, because the usual deformation and indentation hardness tests naturally apply cold work to the metal. If the specimen to be tested is already cold worked, then the actual indentation operation may produce some work softening within the specimen. The hardness test has always been tricky, but this new feature may be a little disturbing. The author says: " Incidentally, for equal linear deformation, extension causes more work hardening than compression both in steels and in cubic non-ferrous metals," but, for all we know, that may be something which is tied up with the hardness test itself. There are directional effects in cold working which may produce work softening, and the difference which is mentioned between the effect of compression and that of tension may be something involved in the hardness test. We may have to think more and more about the application of methods of strainless hardness testing. Some people may feel that this is rather a theoretical matter, but when you consider the way in which it fits in with the reverse drawing procedure—in other words, you can draw a metal further if you put it first of all in an absolutely cold-worked condition—I think that the practical possibilities of this work will be realised.

I believe that we have to consider the effect of this phenomenon upon fatigue. Failure by fatigue is very much in the air at the present time. If it is confirmed that cold working under certain conditions produced work-softening, it may be that it produces a lowering of the fatigue value. There is also this question of the Meyer hardness analysis which may have to be reconsidered. Sometimes in the cold working of copper, for instance, a stage is reached early in the progressive deformation at which the Meyer $n$ value reaches its lower limit and indicates that the metal cannot be strain-hardened any more. Copper reaches this limiting $n$ value at about 30 per cent reduction, and yet after that the copper will still go on strain-hardening. That is a conflict which has never been resolved and it may be that work-softening effects have something to do with it.

Professor H. Ford (Imperial College of Science and Technology): I have a few remarks on the paper by Hessenberg and Sims. I think that we cannot compliment the authors of this paper too emphatically for putting before us experimental values of rolling tests with strip tension. The equipment on which the tests were made is now well tried and well known. The methods of measurement which they have used are of known accuracy. I think that in view of the expense of carrying out such tests as these and the organisation and background of experimental knowledge which are required, it is unlikely that other information of this sort will be forthcoming from any other source, either here or abroad, for some years. We have here the first set of comprehensive results of tension rolling tests which have been put forward, and I think, therefore, that they are of considerable importance. It is a pity, therefore, that more space in the paper has not been given to the experimental results, as compared with the theoretical speculations, and that other metals, and notably copper, have not been used in the tests.

Mr. M. F. Dowding (Davy and United Engineering Company, Ltd.): From the mill builder's point of view I congratulate both Professor Ford and his colleagues and Mr. Hessenberg and Mr. Sims on producing most useful contributions to the very difficult problem of computing roll load and torque for any given reduction when it is necessary to take all variables into account, including forward and back tension.

To compare the two papers is perhaps invidious, but from our point of view the one which produces the answer more quickly, even if it does sacrifice a little accuracy, is the more useful and, providing that there is a good method of computing $P_0$ and $G_0$, the method which is described by Hessenberg and Sims is the one which we have found to be useful in computing the loads which we need to design mills. We compute $P_0$ and $G_0$ from the nomograms which have been worked out as a graphic solution from a previous paper by the same authors. At first sight, the theoretical proof that both back and front tension reduce rolling load seems a gift to the mechanical designer, because if he finds that a pass which he is asked to take is going to overload either the mill bearings or the roll necks he can apply tension and reduce the load to bring it within the capacities which he has available. In theory that is all right, but in practice it is probably necessary to sound a note of warning. I should like to have this confirmed if possible during the discussion by people who actually roll strip themselves. There are times when you can apply front and back tension and times when you cannot. When you see a strip break in a high-speed mill, you know that the times when you cannot apply it are fairly numerous. The condition when the rolling mill operator likes to apply heavy tension back and front is when the metal is soft and thick. Taking the example of rolling thin gauges, say a tinplate gauge, on a reversing mill, in the early passes it is possible to put the tension on fairly heavily front and back, but by the last pass, when the metal is hard and you have left yourself, perhaps, a reduction of about 35 per cent, you should not use more front tension than is needed to keep the coil from collapsing, but you should use as much back tension as you can.

Mr. D. R. Bland (Imperial College of Science and Technology): I have one brief comment on the paper by Smith, Scott and Sylwestrowicz. Professor Ford has already said that we have been writing two more parts in our series of papers and the third part deals with the calculation of the components of the roll force from the elastic part of the roll gap. Looking at a diagram of the roll gap, the minimum thickness recovers before it leaves the roll gap. We have worked out the contribution to the roll force from this part of the roll surface, and find that in many cases it reaches 15 per cent, and on an average is 7–8 per cent. In the course of that calculation we were able to work out the total length of the arc of contact where the strip was in an elastic condition, and therefore the angle at the centre. That angle at the centre can also be worked out very quickly by rough calculation, and the result disagrees with that ascertained by Smith, Scott and Sylwestrowicz in their measurements.

Mr. N. H. Polakowski (University College, Swansea): The three interrelated papers on cold rolling offer an opportunity for comparing some aspects of the mathematical theories of rolling put forward in recent years with the experimental results obtained either in works or during laboratory tests. In this connection the paper by Hessenberg and Sims is particularly valuable, since it offers a realistic basis for discussion. The circumstances that the rolling results reported by these authors were obtained at speeds much below those used commercially does not detract from the value of the work, though a few comparative tests at, say, 200–300ft per minute would have been welcome. They have done particularly good work in making measurements of forward slip as well. The salient feature of their results is the remarkable constancy of the energy consumption figures for any given percentage draft, irrespective of the combination of tensions used. Formula (3) of the papers is quite legitimately based upon this observation; however, with coil 3, for example, there is a small but systematic fall in the energy values towards the higher tension in the strip. The same thing is seen in the third group in coil 5, and perhaps in the last group of results on coil 6.

Dr. B. B. Hundy (B.I.S.R.A., Sheffield): I read Mr. Polakowski's paper with great interest and it agrees with some work of my own on the softening of copper during cold rolling. I took some copper and gave it a reduction of 6 per cent in two passes, keeping the direction of rolling the same for each pass, and hardness measurements showed a surface hardness of about 77 and a core hardness of 70. I then took another sample of the same copper, with the same reduction, also in two passes, and this time reversed it end to end before the second pass. In this case the core hardness was about the same but the surface hardness was only 71. It seems that reversal of rolling gives a product with lower hardness than ordinary straight rolling. Another point is that I found that it is possible to twist

"Armco" iron, with the particular specimens I used, to a shear strain of about 3·5 if it is twisted in one direction only. If, however, you reverse the direction of twist you can twist to a shear strain of about 2·5, and you can then twist it all the way back again before any fracture occurs, a total strain of 5 as opposed to 3·5.

I agree with Dr. Wilson's remarks on the effect of microstructure on this phenomenon. We took a sample of silvered steel, spheroidised one specimen and took the other in the normalised condition with a fairly fine pearlitic structure, and we strained them both about 5 per cent in tension and took samples and found a fair amount of difference between the two. With the pearlitic steel the hardness fell from 336 to about 302, and in the spheroidised steel from 222 to 203. The minimum hardness occurred at a different value of compressive strain, in the pearlitic steel about 9 per cent, and in the spheroidised steel about 5 per cent. To my mind, this seems to agree fairly well with the idea of residual microstresses, and I think that you would expect greater stresses in a pearlitic than in a spheroidised steel, but it does not entirely disagree with Mr. Hessenberg's idea of dislocation. His idea depends on the free path that dislocations can travel along. In the pearlitic steel the path will be shorter in some directions than in the spheroidised steel, but the free path can be quite long if the dislocations travel along the lamellar plates.

*(To be continued)*

# Work of the U.S. Atomic Energy Commission

THE eleventh bi-annual report to Congress of the U.S. Atomic Energy Commission reviews those major developments of the past six months in the atomic energy programme which can be publicly reported. The output of fissionable materials continued to increase during the last six months of 1951, and unit costs continued to decrease. The unit cost reductions were made in spite of increasing labour and materials costs, and are said to be the result of the continuing improvement in production processes and the expanded volume of operations. A substantial portion of the design is complete and construction is now well under way on the new feed materials production centre at Fernald, Ohio. The so-called K-31 addition to the gaseous diffusion plant at Oak Ridge was completed during the period under review. The design and construction of the important gaseous diffusion plant at Paducah, Kentucky, including auxiliary facilities and feed plant, proceeded at a fast pace, despite a series of work stoppages during the summer and autumn. It is hoped that with favourable weather and equipment deliveries some of the lost time can be made up.

### REACTOR DEVELOPMENT

In the period covered by the report, the construction of the experimental breeder reactor was completed at the National Reactor Testing Station in Idaho, and the reactor was brought up to its critical point by the operator, the Argonne National Laboratory. This is the first reactor of appreciable size to operate with fast neutrons, the first fast reactor being a very small unit at the Los Alamos Scientific Laboratory. Already, valuable information has been obtained on the new design, and more data are expected to become available from operating experience. It will be months, however, before the feasibility of breeding can be determined. Many factors will have to be considered, such as the investment of fuel required in a large breeder reactor, and its plants for processing and fabricating fuel elements, the time required to double the amount of fuel invested, and construction and operating costs. The small experimental power plant of this reactor—comprising a heat exchanger, steam turbine, and electric generator—was operated in trial runs in December. Electrical power was generated at the rate of more than 100kW, and used to operate the pumps and other reactor equipment and to provide light and electrical power for the building which houses the reactor. The heat energy produced in the reactor was removed by a liquid metal at a temperature high enough to generate steam to drive the turbine. Power generation is considered to be incidental to the main experimental purpose of the reactor. The power studies are being carried out to secure information on the handling of liquid metals at high temperatures under radioactive conditions and on the extraction of heat from a reactor in a useful manner. The power plant of this reactor can never generate large amounts of electrical power, but it does provide a useful tool for carrying out such experimental studies. The power experiment is in no way intended to establish the feasibility of producing electrical power economically from nuclear sources. The technical information gained, however, may be useful in the design of future reactors aimed at generating electricity at a competitive cost.

Construction of the materials testing reactor facilities and structure at the Idaho testing station has continued. The "MTR" is expected to produce a neutron flux more intense than any now available. A schedule for the first few months' use of this new and much needed facility to make certain irradiation tests of the highest priority for a number of laboratories and contractors was established with the guidance of a policy board representing the various divisions of the A.E.C.

Construction has proceeded at the testing station, of buildings and facilities for a land-based prototype of the submarine thermal reactor power plant. The installation of machinery for this power plant is to be made by the Electric Boat Company, of Groton, Connecticut. Both the construction contractors and the Electric Boat Company are sub-contractors to the Westinghouse Electric Corporation, which will operate the nuclear power plant in consultation with the Argonne National Laboratory. Contractual arrangements are being made for the submarine thermal reactor which is to go into the first nuclear-powered submarine. By agreement between the A.E.C. and the Westinghouse Electric Corporation, the latter will furnish the reactor for the submarine, which the U.S. Navy has named the U.S.S. "Nautilus." The Bureau of Ships of the U.S. Navy has contracted with the Electric Boat Company for the construction of the hull of the "Nautilus," and with Westinghouse for the manufacture of the propulsion machinery. Work has continued at the Knolls Atomic Power Laboratory on design and development for the submarine intermediate reactor. The first installation is to be a land-based prototype of a nuclear power plant suitable for a submarine. Though similar in power specifications to the submarine thermal reactor, this reactor will operate in the intermediate neutron energy range, and is being designed along substantially different lines.

The construction of a chemical processing plant at the testing station is approaching completion. The plant will be used for the separation of unused fuel from used fuel units. In the long-range programme of developing new reactor designs, studies and investigations looking toward production reactors have been intensified. Significant studies of new reactor designs are being carried on by the Argonne, Oak Ridge and Brookhaven National Laboratories, the Knolls Atomic Power Laboratory, North American Aviation, Incorporated, and the H. K. Ferguson Company.

The homogeneous reactor experiment has been continued at the Oak Ridge National Laboratory. This is a pilot reactor, constituting a step in the study of fluidised reactors. Although an "experiment" by comparison with large reactors, the "HRE" will have greater power than the only existing fluidised reactor, the Los Alamos Water Boiler, or the water boiler under construction at the North Carolina State College. Like the experimental breeder reactor, it will ultimately operate a small turbo-generator for heat transfer and power studies. The Aircraft Gas Turbine Department of the General Electric Company, has commenced design and development leading toward aircraft propulsion by nuclear power. Facilities at Oak Ridge, formerly occupied by the Nuclear Energy for Propulsion of Aircraft Division of the Fairchild Engine and Airplane Corporation, were taken over by General Electric and the modification of buildings at Lockland, Ohio, has begun. Plans call for the staff of the General Electric Company at Oak Ridge to move to Lockland by June of this year. This nuclear development is paralleling the development of associated propulsion devices by General Electric and the preparation of the airframe by the Consolidated Vultee Aircraft Corporation, both under the sponsorship of the U.S. Air Force.

The privately financed studies of reactor technology by four industrial groups has progressed. The Detroit Edison-Dow Chemical Group and the Pacific Gas and Electric-Bechtel group submitted reports which are being studied by the A.E.C. More than one hundred engineers and scientists, cleared for access to restricted data, have been giving full or part-time to the studies, examining literature, visiting A.E.C. installations and consulting with people who have been working in the field. It is expected that additional reports will be received by early summer, twelve months after the last agreement was signed. It will be recalled that the agreements provide for surveys and studies by the companies to: (a) determine the engineering feasibility of their designing, constructing, and operating dual-purpose reactors to produce fissionable materials and power; (b) examine the economic and technical aspects of building such reactors in the next few years; (c) determine the possible research and development needed; and (d) recommend the role of industry in designing, building, and operating such reactors.

In September, 1951, the School of Reactor Technology, operated by the Oak Ridge National Laboratory, graduated its first regular class of forty-three engineers. Twenty-three were experienced people from the A.E.C. and its contractors and the military services, and twenty were recent university graduates employed by the laboratory during the course. Immediately after the graduation of the first class, a second class of sixty-seven students began the twelve-month course. The experienced engineers sent by industrial firms continue to receive their salaries while studying at Oak Ridge. Since experienced engineers are not enrolling for this course in the numbers needed by the reactor development programme, consideration is now being given to sponsoring evening courses at industrial centres and short summer courses at educational institutions.

During the past six months useful data were obtained from investigations on the safe disposal of radioactive wastes. Some of the new information has already been applied at atomic energy installations. To ascertain the practicality of utilising sewage treatment methods for removing radioactivity from high-volume, low-level radioactive wastes, investigations were started at the University of California, and at New York and Johns Hopkins Universities. At California, extensive studies are being made of the activated sludge process, while New York University started experimental work on trickling filters. Johns Hopkins University began investigating economic methods for handling low-level wastes, such as those resulting from laundering contaminated clothing worn by atomic energy workers. These studies promise to decrease the cost of disposing of low-level wastes. At Johns Hopkins, also, valuable information was developed on the adsorption of radioactivity by metals used in plumbing systems. It was found, for example, that alloys containing lead and copper are much more susceptible to contamination by iodine 131 than galvanised iron or stainless steel. Such information should prove useful in the design of drainage systems for laboratories using radioactive materials.

The Massachusetts Institute of Technology has completed studies of the removal of certain radioactive elements from water supplies by conventional methods of treatment. This work has already proved of value to the photographic industry in attacking the problem of treating water slightly contaminated by the fall-out following weapon design tests. A group at Harvard University brought nearly to completion a testing programme to evaluate commercial air cleaning equipment in the light of A.E.C. requirements, and completed a *Handbook of Air Cleaning*, which is to be published. The group conducted training and information courses for engineers of the Commission and its contractors, which were also attended by representatives of the National Research Council of Canada from the reactor installation at Chalk River, Ontario. The Bureau of Mines Station in Pittsburgh completed work on the fluxing of ash from an incinerator in which radioactive materials are burned. The ash is fluxed into a lump of sodium hydroxide, so that this concentrated radioactive waste can be more easily handled and disposed of. The station has also made progress with laboratory studies of a small incinerator being developed primarily for users of small amounts of radioactive materials.

### PHYSICAL RESEARCH

About 37,000,000 dollars was allocated to the support of basic and applied research for the fiscal year, 1952, 75 per cent being devoted to research in A.E.C. laboratories and the rest to contracts with universities and private research institutions. A closer association between physical research under contract and the immediate aims of the atomic energy development programme obtained during the last six months of 1951 on such matters as raw materials problems, zirconium production, radiation damage to materials, and the measurement of neutron cross sections. The construction of the 63in cyclotron at Oak Ridge National Laboratory has been completed, and initial testing started in early January, 1952. This cyclotron will accelerate ions heavier than helium. In August, the A.E.C. authorised the construction at Brookhaven National Laboratory of an 18in cyclotron which will accelerate deuterons and protons. Construction is proceeding as rapidly as materials and components can be delivered, and completion is expected in the spring of this year. During the past six months, the synchrotrons at the California Institute of Technology and at the University of Michigan, the cyclotron at the University of Washington, and the synchrocyclotron at the Carnegie Institute of Technology came into initial operation. Also, a Van de Graaff generator which was purchased with funds of the A.E.C., was delivered to Duke University and is in the initial stages of operation. Construction has started on four new accelerators with operation scheduled in 1952. The Van de Graaff generator at the University of Notre Dame will produce electrons of 2MeV energy, and the one at Rice Institute will accelerate protons to 5·5 MeV. The linear accelerator at the University of Minnesota will accelerate protons to 68MeV. These three machines are owned by the A.E.C., and loaned to the universities. The Van de Graaff machine at the University of Texas, partially supported by the A.E.C., is expected to accelerate protons to 4MeV. The years 1950 and 1951 were productive years for the particle accelerator programme—twenty and twenty-one machines respectively came into operation in these years. Because of the increased number now in operation, more research requiring accelerators can be done outside of the national laboratories. Such research is by no means limited to the physical sciences; a number of these accelerators are devoted to biological and medical studies.

Research to bring to light the relatively unknown forces which hold neutrons and protons together to form the nuclei of atoms is being pursued in the A.E.C. laboratories and in universities. An approach to the nature of these forces is the study of the actual energy involved in the formation of a nucleus and the various energy states in which it can exist, if only momentarily. Such research, leading possibly to greater energy releases from the atom, is being actively continued. During the past six months, physicists of Brookhaven have succeeded in bringing together all of the known information regarding the properties of those atoms known as isomers. They have developed a classification scheme which has made it possible to explain many previously inconsistent observations and to predict the existence of several new isomers. These will be used to expand knowledge if the nucleus. At the University of California Radiation Laboratory, the energy states of the helium 4 nucleus were studied by bombarding helium gas with protons from the linear accelerator. It was found that the helium 4 nucleus cannot be raised to a higher energy state with less than 23MeV. In addition, observations showed that some of the bombarded helium 4 atoms were transformed to helium 3 by the emission of deuterons, a previously unobserved reaction.

## Technical Reports

*The Study of Balanced Harmonics in an Overhead Ring Main System (East Cornwall Tests) (Report Ref. M/T*105). By A. Butterworth, B.Sc. (Eng.), A.M.I.E.E. and H. R. J. Klewe, Dr.Phil. The British Electrical and Allied Industries Research Association, Leatherhead. Price 15s.—This report compares the results of calculation and measurement of the flow of harmonics generated by a single rectifier fed from an extended 33kV overhead ring main system. It is concluded that calculation gives reliable results up to frequencies of 1500 c/s. Within this range calculation is shown to be capable of assessing and, if necessary, predicting the nature and causes of disturbances. Where, as in the present case, the rectifier load is only a small proportion of the total load, effects at frequencies up to 550 c/s may be masked by harmonics due to transformer magnetising currents.

*A Survey of the Sulphur and Sulphuric Acid Position.* D.S.I.R. London. H.M. Stationery Office. Price 1s. 6d.—This survey discusses the world shortage of sulphur and the various factors involved in procuring it. The report shows that the U.S.A. is the chief source of sulphur and in 1951 exported some 900,000 tons, about half of which was for the United Kingdom. American sulphur comes from the domes in Texas and Louisiana, but a recent estimate suggests that there is enough there for only fifteen years at the present rate of mining. Sulphur occurs in other countries but not in any great amount. The survey notes other means of obtaining sulphur or sulphuric acid—for example, from pyrites. The largest reserve is in Spain and Portugal. Large deposits exist in the U.S.A. and Canada, but neither have been developed on any scale. The pyrites content of coal is another potentially important reserve. Present recovery is negligible. In England the only important raw material for sulphuric acid is anhydrite, of which extensive deposits occur at Billingham and in Cumberland. A new company has been formed to produce the acid, but it will be some years before the plant will come into operation.

The survey discusses other sources of sulphur. Some 300,000 to 400,000 tons of sulphur a year are burned with the 30 million tons of coal consumed by power stations in this country. The Fuel Research Station, D.S.I.R., is looking into this problem and has erected a pilot plant for washing the gases. Blast-furnace slag is another potential source of sulphur, estimated at 100,000 tons. The survey also gives details of many methods of conserving sulphuric acid, mainly in the fertiliser industry and in iron and steel pickling.

## Continental Engineering News

*(By our Continental Correspondent)*

### Extensions at Antwerp Harbour

In order to develop the activities of the port, important works started about a year ago in Antwerp. These works mainly concerned the erection of the new Baldwin lock ("Ecluse Baudouin") and the construction of oil refineries. A new maritime station for the Compagnie Maritime Belge (C.M.B.) was opened in May, 1951, while a large dock for oil tankers was put in service in September, 1951. The construction of the Baudouin lock is progressing satisfactorily. At present the total volume of excavation amounts to some 380,000 cubic yards, which is about 80 per cent of the total earthwork required for the project. Steel sheet piling is being driven along the lock walls, and a modern concreting plant has been installed with a daily output of some 1300 cubic yards.

### Reconstruction of the Vienna Opera House

The State Opera House at Vienna was badly damaged during the war. After the end of the hostilities the Austrian Government decided to rebuild the famous Opera House to its pre-war design. The reconstruction contract was let to the firm Waagner-Biro. The restored roof is supported by a series of two-hinged steel arches, 117ft long, spaced at about 17ft centres. The arches are of plate girder construction, assembled by arc welding. They are provided with tie members. The roof has the same appearance as that of the pre-war structure, but its acoustical properties are considerably improved. This result was achieved by using a 1¼in thick reinforced concrete shell, provided internally with two layers of "Heraklith" and externally with roof felting, supporting the copper sheets of the roof, all carried on steel purlins. The lateral stability of the system is ensured by suitable wind bracing.

### The Helder Military Port, Holland

Extensive works are at present being carried out at the Dutch military port of Helder, in the northern part of the country. The port was founded in the eighteenth century by King William V, and is now being enlarged and modernised to meet the needs of the Royal Dutch Navy. A navigation channel, about 560ft long, will link the new port with the ancient harbour. The main works include the construction of a large circular dock having a diameter of 1640ft, two quay walls on the western bank, and a series of jetties. There will also be a storage basin and a dry dock. Work was commenced in 1949 with the construction of a cofferdam dyke, which will be completed this year. The construction of various jetties and quay walls is going on at the same time. A bridge will be built over the Nieuwe Diep (ancient harbour). All the works are due for completion by 1954. The construction of the jetties and quay walls presented some difficult problems, because of the poor bearing capacity of the soil. Piled foundations were adopted and more than 1000 piles have been prefabricated on the shore and driven.

### A Welded Exhibition Hall in Holland

Recently, the Philips Company celebrated its diamond jubilee. For this occasion it was decided to erect a large jubilee hall in Eindhoven, and the hall was built by the constructional firm De Vries Robbé and Co. It is a steel-framed structure, 200ft long, with a clear span of about 135ft and a height of 45ft from the floor to the top of the frame. The steelwork, the weight of which amounts to 250 tons, was assembled by arc welding; it is of interest to mention that the overall length of the welded joints exceeded 16,500ft. The framework consists of plate girder three-hinged portal frames, spaced 28ft apart. The inside flanges of the legs were kept vertical, while the outside flanges are sloping, thus giving the structure a rather unusual appearance. The portal frames were assembled on the ground and then hoisted in position with an erection mast. The hall is covered with a light timber roof. The whole construction was erected in a very short time.

# Industrial and Labour Notes

### Engineering Wages

At the annual conference of the national committee of the Amalgamated Engineering Union, which has just been concluded at Blackpool, there was considerable discussion on the subject of wages in the engineering industries. One resolution, which was unanimously adopted on Wednesday of last week, called for an increase of £2 a week (of forty-four hours) for all adult male workers.

This resolution was carried against the advice of members of the union's executive who suggested that other unions allied to the Confederation of Shipbuilding and Engineering Unions might feel that the A.E.U. was trying to dominate that body's activities. Another resolution which was passed on the same day urged that piecework earnings should be based on a full consolidated rate and that piecework prices should be such as would enable a man to earn at least 50 per cent on the consolidated time rate. The resolution about the £2 a week demand will now go to the Confederation of Shipbuilding and Engineering Unions for further action. The Confederation has already put forward a claim for a "substantial wage increase."

The wages discussion was continued by the conference on Thursday of last week. One resolution which was carried on that day asked for the bringing into effect of a new wages structure in the engineering industry on an increased percentage basis of the 1948 wages structure. Other resolutions related to the wages of apprentices. One of them called for an increase of £1 a week for all apprentices and youths and another asked that negotiations should be hastened for a revision of the percentage wage scale for apprentices. Both resolutions were carried.

### Railway Wages

As recorded in these notes on April 25th, the three railway unions—the National Union of Railwaymen, the Associated Society of Locomotive Engineers and Firemen, and the Transport Salaried Staffs Association—have been discussing railway wages. At the end of last week it was announced that the three unions had decided to make immediate demands for an increase of 10 per cent in the wages and salaries of all their members. This latest demand on the part of the railway unions also includes a claim for the payment of time-and-a-half for all work done between noon and midnight on Saturdays. Last November, it will be recalled, railwaymen were given a wage increase approximating to 8 per cent on existing rates. That award was made retrospective to September.

### Employment and Unemployment

The latest statistics on the employment situation in Great Britain—issued early this week by the Ministry of Labour—show that there was little change in the working population during the month of March. At the end of that month the total working population was estimated to be 23,443,000 (16,030,000 men and 7,413,000 women). Those serving in H.M. Forces numbered 863,000 and in civil employment there were 22,122,000 (14,946,000 men and 7,176,000 women), which was 34,000 less than at the end of February.

Employment in the country's basic industries, however, increased during March, and by the end of the month 4,091,000 people were at work in that group, or 13,000 more than a month earlier. There was an increase of 2000 in colliery manpower, bringing the total to 711,000, and a seasonal increase of 10,000 in the number employed in agriculture. The decline occurred in the manufacturing industries, all of which reported a decrease in the number employed. The total number of people at work in those industries at the end of March was 8,694,000, or 57,000 fewer than at the end of February. By far the largest part of the decline was in the textile industries, although in the group classified as "engineering, metal goods and precision instruments," the total number of people employed fell by 3000 to 2,594,000. In other industries and services, building and contracting added 14,000 to their manpower, bringing the total to 1,423,000.

The Ministry's latest figures on unemployment relate to April 21st, when there were 467,871 people registered as out of work, compared with 432,974 on March 17th. The April figure included 142,799 people described as being temporarily stopped. In the last week of March, about 276,000 operatives in manufacturing establishments rendering returns were reported to be on short time, each losing sixteen hours on the average. In the same week there were 1,177,000 who were working, on an average, seven and a half hours overtime.

### The Redistribution of Manpower

During a debate on the manpower situation in the House of Lords, on Wednesday of last week, the Chancellor of the Duchy of Lancaster, Lord Swinton, made reference to the redistribution of skilled labour. He said that to assist in that redistribution and to secure the proper use of workers where there were shortages, the experiment was being tried of having a limited number of highly qualified labour supply inspectors.

Lord Swinton explained that where employers notified demands for particular kinds of labour, and it seemed unlikely that those demands could be met easily, or there was doubt about whether the services of workers with particular skills were being fully used, inspectors visited the employers and, with their co-operation, examined the position. They assessed requirements, considered possible alternative ways of meeting them, and, where appropriate, discussed and secured the agreement of employers and trade unions to measures which would reduce the demands for scarce skilled men. That might include further training and up-grading. This service, Lord Swinton explained, had been operating for rather less than two months, but already, he thought, pretty good results had come to hand.

Later in his speech, Lord Swinton mentioned the shortage of highly skilled men, especially in the engineering industry. It was not, he said, just that the industry was short of skilled men, but the rate at which the lesser skilled or unskilled workers could be absorbed often depended entirely on the rate at which skilled workers could be found. In certain areas, therefore, special housing allocations were being made to help in attracting skilled workers needed for highly important work. Those measures, of course, Lord Swinton continued, would not wholly meet the shortage, and industry had been asked to help by training and upgrading workers either directly or by making use of the facilities provided at Government training centres.

### A World Economic Survey

The United Nations department of economic affairs has produced a "World Economic Report," which surveys the principal developments in industrial production and trade during 1950 and 1951. It suggests that, after about a year and a half of widespread rearmament activity, the world was in the position of having produced more goods in 1951 than in any year previously. It also comments that the expectations of scarcity on which the raw material boom in the latter half of 1950 had been based proved exaggerated. Within the framework of controls and fiscal measures established by the various Governments, raw material supplies in 1951 were, in fact, sufficient to allow generally an even greater expansion of industrial output in that year than had occurred in 1950.

In one of its chapters the report shows that industrial production rose last year in all the developed private enterprise economies of the world, but at varying rates. The rise in gross national product, however, was generally less than that in industrial production, since the increases in other sectors of the economy did not match those in industry. Though there was some general rise in the level of employment, there were, in countries where output rose sharply, large increases in average output per man, so that the rise in employment lagged considerably behind that of production. In Denmark and the Netherlands, the report observes, which instituted deflationary policies to cope with balance of payments difficulties, unemployment rose significantly towards the end of last year.

Dealing with the impact on world trade of the "raw material boom," the report says that, beginning in the second quarter of 1951, the U.S.A.'s imports of raw materials declined substantially from peaks reached in the preceding two quarters, and continued to decline throughout the second half of 1951. An important element in this situation, the report comments, was the relaxation of demand resulting from United States government policy. In contrast, raw material imports by Western Europe as a whole, which had not increased in the second half of 1950, rose in the first half of 1951. There consequently appears to have been an improvement in the level of raw material stocks in several Western European countries where stocks had run down during 1950.

### Practical Help in Foremanship

The Industrial Welfare Society has announced particulars of a residential course for foremen which is to be held at Horsley Towers, Surrey, from Monday to Friday, June 9th to 13th. The general theme of this course is "Practical Help in Foremanship," and the programme will include lectures on the techniques of interviewing and starting the newcomer, the work of specialists in industry and the help they can give to the foreman, and the skills of communicating with others through speech and writing. Each lecture throughout the course will be based on a practical session devoted either to case studies or to practice in the writing of reports and the giving of instructions. The programme will include also discussion on the working environment, during which such matters as colour, lighting, ventilation and heating will be considered in relation to legal requirements, safe practice and efficiency. The membership of the course is limited to thirty. Information about it can be obtained from the Industrial Welfare Society, Robert Hyde House, 48, Bryanston Square, London, W.1.

### Britain's Overseas Trade

According to provisional figures announced this week by the Board of Trade, the value of exports of United Kingdom goods during April amounted to £217,600,000, which was £21,900,000 below the monthly average for the first quarter. On account of the Easter holiday there were only twenty-four working days in April—instead of the normal twenty-six—and this is a factor which must, of course, be taken into account when considering the decrease.

The Board of Trade says that the extent to which the Australian import restrictions and measures taken by other sterling countries in the Commonwealth may also have contributed to the decline in exports will not be known until the detailed figures for the month are available. Re-exports were also low, reaching a figure of £11,500,000, compared with an average of £18,300,000 in the first quarter. In this case, the Board of Trade says that the April figure reflects the falling off of the special shipments of rubber and tin.

The value of imports in April has been given provisionally as £325,200,000, which was very slightly below the average for the first quarter of the year. The excess of imports (c.i.f.) over the total exports (f.o.b.) was therefore £96,100,000 in April, compared with a monthly average of £70,400,000 in the first quarter of this year.

# Notes and Memoranda

## Air and Water

The Hawker "Hunter" Interceptor.—The Hawker Aircraft Company, Ltd., has obtained a short lease upon the Teddington film studios as part of the production plans for the "Hunter" and "Sea Hawk" jet aircraft.

Dry Dock Owners.—At the annual general meeting, held in Edinburgh on May 7th, Mr. Alexander Traill, O.B.E., director and general manager of Manchester Dry Docks Company, Ltd., was elected chairman of the Dry Dock Owners and Repairers Central Council and Mr. W. B. Johnstone, O.B.E., and Mr. A. G. Waddy, O.B.E., were elected, respectively, senior and junior vice-chairmen.

Newark Lock.—A large new lock at Newark, built by the Docks and Inland Waterways Executive to facilitate the movement of traffic on the Trent Navigation between the Humber and Nottingham area, has been officially opened. The new lock is 192ft 10in long, 30ft 2in wide, with a depth of water 8ft 6in. It will pass in one operation a unit of four standard Trent craft carrying about 500 tons, or a large single craft of 200 to 250 tons capacity.

British Steam Catapult.—The catapult developed by Brown Brothers and Co., Ltd., for the Royal Navy uses the principle of the slotted cylinder and has no rams or purchase cables. It was installed for trial purposes in H.M.S. "Perseus" and, following the success of the trials, further tests were carried out at the United States Naval Shipyard, Philadelphia, the naval base Norfolk and at sea. The new steam-powered catapult proved capable of projecting the U.S. Navy's jet fighters into the air with the aircraft carrier headed down wind or moored, and the catapult will be adapted for use in U.S. aircraft carriers, while the possibility of fitting it to the new flush deck carrier U.S.S. "Forrestal," now under construction, is being investigated.

The "Marathon" Aircraft.—As part of the expansion programme of the Royal Air Force, thirty "Marathon" aircraft have been ordered from Handley Page (Reading), Ltd., for service as advanced navigation trainers. With large cabins a cruising speed of 200 m.p.h. and a range of 1400 miles the "Marathons" will be able to make long advanced training flights from the United Kingdom as far afield as Malta and Gibraltar. Each aircraft will carry a staff navigator and two student navigators, in aft-facing seats, and a staff pilot and signaller. The "Marathon" is equipped with such navigational training aids as Rebecca Mark 4, Gee and radio compasses and the provision of astrodomes and peardrop windows which will give the trainees an all-round view. It is a high-wing monoplane with tricycle undercarriage and four D.H. "Gipsy Queen" engines, and, when fully loaded will maintain height on any two of its engines. As a civil transport, "Marathons" have been ordered for service with Union of Burma Airways and with the West African Airways Corporation. They are the only eighteen-seat to twenty-two-seat feeder service airliners in full-scale production and their performance exceeds international safety requirements.

## Miscellanea

Obituary.—We have learned with regret of the death, which occurred recently in Coventry, of Mr. E. H. Johnson, a director of Keelavite Rotary Pumps and Motors, Ltd. We also note with regret the death of Mr. James Mackie, A.M.I.Mech.E., which occurred suddenly in Glasgow on April 28th. Mr. Mackie was Scottish technical representative of Macrome, Ltd., Wolverhampton.

International Instrument Congress.—The first International Instrument Congress and Exposition is to be held in the Commercial Museum and Convention Hall, Philadelphia, September 14 to 24, 1954. An invitation has been extended to foreign manufacturers to exhibit their products at the congress, which will celebrate the tenth anniversary of the Instrument Society of America.

Chartered Surveyors' Examinations.—The Royal Institution of Chartered Surveyors has published a booklet announcing the inauguration of an additional division of its professional examinations for candidates training in the surveyor's contribution to town and country planning. These new examinations are specially designed to implement the recommendation of the Schuster Committee that specialists engaged in planning should be qualified not only in their technique but also in its application to planning. Knowledge of much that is fundamental to planning—land use, land values, estate management and development—is basic to the qualification of a surveyor, and these have always been matters on which chartered surveyors have made their contribution to the planning process. The conditions governing admission to the examinations are explained in the booklet, which is obtainable (price 6d., post free) on application to the Secretary, the Royal Institution of Chartered Surveyors, 12, Great George Street, London, S.W.1.

Oil Burner Manufacturers' Association.—At the recent annual general meeting of the British Oil Burner Manufacturers' Association, Mr. A. G. Dobbs, M.I.Mech.E., of Wallsend Slipway and Engineering Company, Ltd., was elected president; Mr. J. R. C. Boyce, of British Oil Burners, Ltd., and Mr. J. Fitzgerald, of Combustions, Ltd., were elected vice-presidents.

Retirement of Lieut.-Colonel K. G. Maxwell.—Lieut.-Colonel K. G. Maxwell, M.C., M.I.E.E., has retired from the position of manager of the publicity department of Metropolitan-Vickers Electrical Company, Ltd., Trafford Park, Manchester, after forty-one years in the company's service. He has been manager of the publicity department since 1933 and will continue to serve the company in an advisory capacity. Mr. E. E. Walker, assistant manager of the publicity department, has succeeded Lieut.-Colonel Maxwell.

Brassfoundry Productivity Conference.—The Association of Bronze and Brass Founders and the National Brassfoundry Association are organising a brassfoundry productivity conference, which is to be held at Harrogate, from Monday to Thursday, June 23rd to 26th. The principal object of the conference is to discuss methods of implementing the recommendations made in the report of the brassfoundry productivity team following its visit to the U.S.A. Full particulars of the conference can be obtained from the secretaries, Messrs. Heathcote and Coleman, 25, Bennetts Hill, Birmingham, 2.

A Building Plant Exhibition.—A building plant exhibition, which will bring together on one site up-to-date machinery and equipment for builders, is to be held in Preston, June 12th-18th. Organised by the Ministry of Works in association with manufacturers of building plant and equipment, the exhibition will cover an area of 100,000 square feet in the car park of the Preston North End football ground, Deepdale Road. Equipment to be demonstrated on the site will include a tower crane capable of lifting material up to 138ft, earth augers, concrete mixers, scrapers, scaffolding, tractors, bulldozers, powered barrows and mobile hoists. There will also be demonstrations of powered hand tools.

Coal Board's Research Work.—To meet the pressing need for increased research in the mining industry, the National Coal Board has bought a building and site at Isleworth, Middlesex, in order to set up a new central research establishment. The building can be used immediately for some of the work which the Board wants to put in hand and it can be extended and developed when the building situation becomes easier. The new centre will be devoted to the investigation of underground problems. The existing central research establishment at Stoke Orchard will concentrate on research into coal processing and carbonisation, with a view to finding ways of making the best and most economical use of the country's coal resources.

Conservation of Scarce Materials.—To assist the U.S. Office of Defence Mobilization to carry out its objectives, the American Society for Testing Materials has been requested to develop methods of conservation of scarce materials, through the use of substitute materials or through more efficient use of materials. By formal contract, these services will be rendered to the recently appointed consultant to the Director of Defence Mobilization on Conservation of Materials, Mr. John R. Townsend of the Bell Telephone Laboratories. Individual projects will be undertaken at the request of the consultant and reports will be furnished to him. The Society says that among the services to be rendered under the contract are the collection and organisation of factual knowledge and reliable opinion dealing with the conservation of materials by using the extensive facilities available to the Society, notably through its technical committees. Development of emergency and substitute A.S.T.M. tests and specifications will also further the cause of conservation. The Society will also use its facilities to inform its members concerning needs for conserving critical materials and various ways in which such conservation may be accomplished. The first project to be undertaken concerns the conservation of nickel.

Iron and Steel Engineers' Meeting.—The iron and steel engineers group of the Iron and Steel Institute is holding a meeting for junior engineers (below the age of thirty-five) on Monday, Tuesday and Wednesday of next week, May 19th to 21st, at Ashorne Hill, Leamington Spa. The proceedings will begin on Monday evening with a discussion on "The Rehabilitation of a Slab Mill," and on Tuesday the subjects for discussion are "Experiences of a Lubrication Engineer in Iron and Steel Works," and "The Use of Lubricants in the Iron and Steel Industry." On Wednesday morning "Locomotives in Iron and Steel Works" will be discussed, the meeting concluding at noon on that day.

## Personal and Business

Mr. F. J. Larard, M.I.E.E., has been appointed manager of the London office of Brush Export, Ltd.

Mavor and Coulson, Ltd., Glasgow, states that Mr. R. J. Hird, chief engineer, has been appointed a director.

Mr. John Creek has been appointed general sales manager of Fibreglass Ltd., Ravenhead, St. Helens, Lancs.

Mr. Basil H. Tripp has been appointed information and press officer to the Council of Ironfoundry Associations.

Mr. F. G. Hawkings has been appointed home sales director and Mr. E. C. Marland, technical director, of Platt Bros. (Sales), Ltd., Oldham.

Sir Wilfrid Eady has been appointed a whole-time director of Richard Thomas and Baldwins, Ltd., and a director of the Steel Company of Wales, Ltd.

Reed Brothers (Engineering), Ltd., has acquired additional premises near to its main works at 151–163, Westferry Road, Millwall, London, E.14.

Metalock (Britain), Ltd., has opened an office at 33, The Temple, 24, Dale Street, Liverpool (telephone, Liverpool Central 3820). Mr. A. Tinwell is area manager.

Mr. S. C. Tyrrell, local director and chief accountant of Newton Chambers and Co., Ltd., has been appointed president of the Institute of Cost and Works Accountants.

Macrome, Ltd., announces that, pending the appointment of a Scottish technical representative in place of the late Mr. James Mackie, all inquiries will be dealt with at the office at 249, St. Vincent Street, Glasgow, C.2.

George Ellison, Ltd., Perry Barr, Birmingham, states that its Scottish area sales office is being moved on May 21st to 7, Woodlands Terrace, Glasgow, C.3 (telephone, Douglas 5335; telegrams, "Induction, Glasgow, C.3").

The Western Region of British Railways announces the following appointments:—Mr. S. Stevens, M.Sc. (Eng.), A.M.I.C.E., district engineer, London; and Mr. H. G. Lakeman, A.C.G.I., A.M.I.C.E., district engineer, Bristol.

Dr. H. Hollings is relinquishing, at the end of June, his appointments as director of the London research station of the Gas Council and as controller of research, North Thames Gas Board. Dr. R. H. Griffith has been appointed his successor in both offices.

Warsop Power Tools, Ltd., announces the opening of a new depot at Hopgoods Yard, Southend Road, Basingstoke. Larger premises have also been taken by the company at Carlton Road, South Croydon (telephone, Croydon 8017), and at Gelderd Road, Gildersome, Leeds (telephone, Leeds 39359).

Ford Motor Company, Ltd., Dagenham, announces the retirement of Mr. A. Haselden from his position as director of manufacture. Mr. Haselden, who joined the Ford Motor Company in Detroit in 1911, is being retained as an adviser. His successor as director of manufacture is Mr. C. Thacker.

Dr. Paul D. Merica has been elected president of the International Nickel Company of Canada, Ltd. Dr. John F. Thompson, the retiring president, continues as chairman and chief officer of the company. Mr. R. Leslie Beattie and Mr. H. C. F. Mockridge have been elected to the executive committee of the board.

International Harvester Company of Great Britain, Ltd., announces the retirement of Mr. Arthur J. Purves from the position of managing director. Mr. Purves, who joined the company in 1911, will continue to serve on the board. Mr. Brooks McCormick, who was appointed joint managing director last year, has now become sole managing director of the company.

# British Patent Specifications

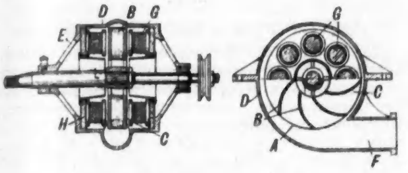
*When an invention is communicated from abroad the name and address of the communicator are printed in italics. When an abridgment is not illustrated the specification is without drawings. The date first given is the date of application; the second date, at the end of the abridgment, is the date of publication of the complete specification.*

*Copies of specifications may be obtained at the Patent Office Sales Branch, 15, Southampton Buildings, Chancery Lane, W.C.2, 2s. 8d. each.*

## ELECTRICAL ENGINEERING

**669,666.** August 25, 1949.—Electric Air Heaters, Silto S.A., of 37, Faubourg Saint-Denis, Paris (Seine), France.

According to the invention a rotary fan draws air from the atmosphere, and delivers it inside the vehicle to be heated. The centrifugal fan used has a rotor *A* provided with blades *B* fixed between two discs *C*. The shaft and the rotor are housed inside a casing *D* with air inlet apertures *E* and with a discharge tangential outlet pipe *F*, communicating with the inside of the compartment or space to be heated. To heat the air Foucault currents are created in the fan rotor, which rotates in the magnetic field of electro-magnets *G* energised from the battery of the vehicle. The electro-magnets *G* are mounted in partitions *H* of magnetic metal. When the electro-magnets are energised, Foucault currents occur inside the rotor and produce an intensive heating effect. The rotor is cooled down by the air which it thus heats and delivers. By varying the intensity of the electro-magnet energising current with a rheostat, the heating effect can be adjusted. The control means are also described in the specification.
—*April* 9, 1952.

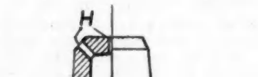


No. 669,666

## VALVES

**670,185.** April 1, 1949.—Valves for Controlling the Discharge of Steam, Elson and Co., 1920, Ltd., Mead Works, Horninglow Street, Burton-on-Trent, Staffordshire, and Eric Elson, of the company's address.

The invention concerns valves in which a discharge nozzle on the end of a hollow valve spindle is depressed to open the valve, to allow steam to pass through the nozzle. As illustrated, the valve body has a hollow cylindrical portion *A* with a shoulder which forms a valve seat *B*. The enlarged end of the body screws into a flange which is fixed to the steam pipe supply. A valve stem *C* slides in the bore of the body and the inner end of the stem forms the valve head *D* on the steam inlet side. Annular oiling grooves are formed around the stem of the valve. The valve stem is bored as shown and an annular groove *E* is formed around the stem above the seat. When the valve is open the steam passes into the annular groove and through holes *F* in the bottom of the groove into the bore of the stem. The outer end of the valve has a hollow nozzle *G* screwed on it so that the steam will pass into the interior of the nozzle and through discharge orifices *H*. The outer end of the valve body and the inner end of the nozzle have flanges *J* and *K* and a spiral spring is mounted between them to press the nozzle out and return the valve into the closed position. Rubber sealing rings *M* and *N* are provided so that any escape of steam through joints is prevented. —*April* 16, 1952.

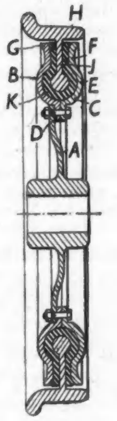


No. 670,185

## ROAD TRANSPORT

**670,380.** November 3, 1949.—Vehicle Wheels, Dunlop Rubber Company, Ltd., 1, Albany Street, London, N.W.1, and Bernard William Deacon Lacey, of the company's works, at Fort Dunlop, Erdington, Birmingham, 24.

The invention relates to vehicle wheels of the type wherein resilient elements of rubber or the like are interposed between the rim and the hub. Referring to the drawing, the wheel hub has an outer flange *A*, to which is secured a detachable channel member *B* of "U"-shaped section. It comprises two annular plates *C*, each having a radially aligned inner portion *D*, an annular groove *E*, which is part circular in section, and an outer portion *F*, the outer ends *G* of which are flared outwards. The inner portions of the two plates are clamped together by means of bolts. The wheel rim *H* has a central inner flange *J*, the inner extremity of which is bulbous and circular in shape. Rubber *K* is clamped between the channel and the ring flange to fill the "U"-section spaces. It may be clamped on assembly so that it has a lateral compression loading.—*April* 16, 1952.

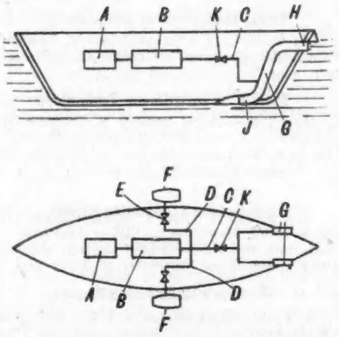


No. 670,380

## MARINE ENGINEERING

**669,672.** October 11, 1949.—Ship Propulsion, Société pour l'Amelioration de la Propulsion a Bord des Navires S.A.R.L., 30, Rue Tronchet, Paris, France.

The apparatus for propelling the ship in accordance with the invention comprises a heat engine *A*, a compressor *B*, a pipe *C* and compressed gas pipes *D* connected with the conduit *C* and provided with valves *E* which introduce the gas into the propulsion devices *F* which are in the form of divergent-convergent nozzles. Means for bringing the ship to running speed are provided by tubes *G* having an upper end *H* and a lower end *J*. The conduit *C* is connected to the lower portion of these tubes for introducing compressed gas in the control valve *K*. When the ship is under way the valves *E* are closed and the valve *K* is open. The motor compressor unit is started and the compressed gas, which is usually air, flows into the propulsion tubes *G* and forms a gas-liquid mixture and, owing to the difference in density between this mixture and the outer water, a current is created. The velocity of the outgoing gas-liquid expanding mixture is greater than its incoming velocity, and creates a propulsive force which sets the ship in motion. When the ship reaches running speed the valves *E* are opened and the valve *K* is shut. Due to the movement of the ship, water flows into the cruising propulsion units *F* and is put under pressure by the divergent inlet, where it is emulsified and the gas-liquid mixture which expands in the convergent outlet portions of units flows out with increased kinetic energy, the reaction maintaining or increasing the ship's speed. A tube device similar to *G*, but having its outlet in the reverse direction, can be utilised for reverse motion. It is stated that a thrust of from 7 to 8 tons for a speed of 10m per second can be applied for propelling a ship, through utilisation of the mixture of water with the gaseous mixture under pressure in accordance with the invention, with a fuel consumption equivalent to that of 10,000 h.p. in a heat engine.—*April* 9, 1952.

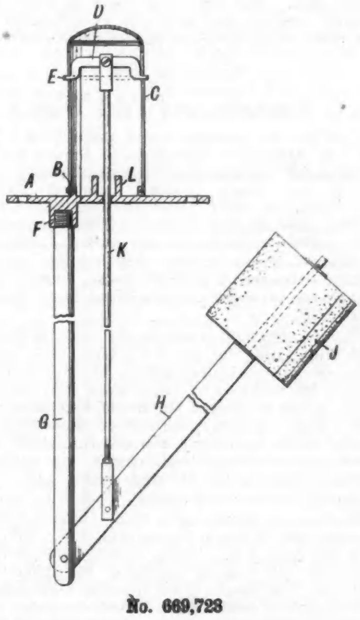


No. 669,672

## MEASURING DEVICES AND INSTRUMENTS

**669,728.** June 14, 1950.—Liquid Level Gauge, Standard Oil Development Company, Elizabeth, New Jersey, U.S.A. (*Inventor: Albion Henry Gregory*).

Referring to the drawing, *A* is a base plate to which the cylindrical indicator dome *B* is secured. In the sides of the dome are two vertical opposed slots *C* and within the dome is a cross member *D*, which passes through the slots and is secured to the indicator ring *E*. From the lower face of the base plate there projects a threaded socket *F*, into which is screwed a vertical rod or pipe *G*. The lower end of the rod is slotted to support a pivoted float rod *H*. At the far end of the float rod is mounted a float *J*. An indicator rod *K* is connected at one end to the cross member *D* and at the other end to float arm *H*. The rod passes through a hole in the base plate, which is surrounded by a vertical annular flange *L*, which serves to prevent rain water from entering the tank.—*April* 9, 1952.

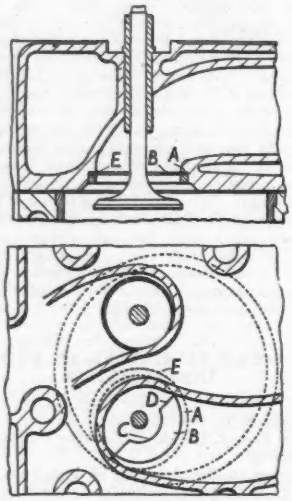


No. 669,728

## INTERNAL COMBUSTION ENGINES

**670,181.** March 19, 1949.—Compression Ignition Engines, William Wilson Hamill, Arthur William Bird and Henry Meadows, Ltd., of the company's address, Fallings Park Engine Works, Park Lane, Wolverhampton.

The invention provides a means for promoting air swirl in the combustion chamber of an internal combustion engine and it consists of an inserted valve seat incorporating an integral segmental portion which projects into the air inlet passage so as to obstruct one side. As shown in the drawings, the segmented member includes an outer securing ring *A* with an inwardly projecting segment *B*, which extends through an angle of, say, 170 deg. Part *C* of its inner edge is curved to a radius struck from the valve stem axis and the rest of the edge is shaped as chords *D*, forming a segmental annulus. The securing ring has the same internal diameter and the same external diameter as the valve seat *E*, which is either pressed or screwed into position in a recess in the cylinder head to grip the securing ring and hold it firmly in position. In order to enable the optimum position to be experimentally determined for each cylinder the member may be adjusted angularly about the axis of the inlet valve, after which it is secured in position by the inserted valve seat. The projecting segment may be of various shapes and differing constructions are described in the specification.—*April* 16, 1952.



No. 670,181

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## Launches and Trial Trips

**Caledonien**, passenger and cargo liner; built by Les Ateliers et Chantiers de France for Les Messageries Maritimes; length between perpendiculars 156m, breadth moulded 20·60m, depth moulded to "C" deck 15·50m, load draught 7·89m, displacement 17,500 tons, deadweight 9350 tons, service speed 15 knots; two Saint-Nazaire-B. and W. diesel engines, each has ten cylinders 620mm diameter by 1150mm stroke, 6000 b.h.p. at 150 r.p.m., arranged to burn heavy fuel. Launch, April 26th.

**King Alexander**, cargo liner; built by Harland and Wolff, Ltd., for the King Line, Ltd.; length between perpendiculars 435ft, breadth moulded 59ft, depth moulded to shelter deck 39ft, two steel decks, seven watertight bulkheads, four main holds and a deep tank, derricks include one 50 ton and one of 20 ton capacity; Harland-B. and W. four-stroke, single-acting diesel engine, six cylinders, 740mm diameter by 1500mm stroke, 115 r.p.m., three 125kW diesel generators. Trial, May 6th.

**Stanley Angwin**, cable ship; built by Swan, Hunter and Wigham Richardson, Ltd., for Cable and Wireless, Ltd.; length overall 315ft, breadth moulded 41ft, depth moulded to upper deck 25ft 9in, deadweight 2200 tons on 19ft draught, two complete decks, three cylindrical cable tanks of 18,850 cubic feet total capacity, two independent cable gears; two triple-expansion engines, cylinder diameters 15in, 25½in and 44in by 27in stroke, 1450 i.h.p. total at 104 r.p.m., two multi-tubular Scotch boilers supply steam at 220 lb per square inch. Trial, May 7th.

**Irish Coast**, cross-Channel vessel; built by Harland and Wolff, Ltd., for Coast Lines, Ltd.; length between perpendiculars 320ft, breadth moulded 51ft 6in, depth moulded 19ft, gross tonnage 3600; accommodation for 242 first-class passengers and 146 third-class passengers, 750 passengers carried on Steam 2 Certificate and 1200 passengers under a Steam 2 Limited Certificate; two two-cycle, trunk-piston Harland-B. and W. diesel engines, each have ten cylinders, 500mm diameter by 900mm stroke, 155 r.p.m., three 250kW diesel generators. Launch, May 8th.

**Wareatea**, cargo ship; built by Henry Robb, Ltd., for William Holyman and Sons, Pty., Ltd., Tasmania; length between perpendiculars 240ft, breadth moulded 37ft, depth moulded to upper deck 16ft, deadweight 1500 tons, speed 11¾ knots trial; Atlas Polar diesel engine, 1780 b.h.p. at 250 r.p.m. Trial, May 8th.

M.S.C. **Quest**, tug; built by Henry Robb, Ltd., for the Manchester Ship Canal Company; length overall 95ft, breadth moulded 24ft, depth moulded 12ft; two Crossley four-cylinder diesel engines, total output 1200 b.h.p. at 250 r.p.m. Trial, May 8th.

## Forthcoming Engagements

*Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of their insertion, the necessary information should reach this office on, or before, the morning of the Monday of the week preceding the meetings. In all cases the* TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

### Incorporated Plant Engineers

*Mon., May 19th.*—Liverpool and N. Wales Branch: Radiant House, Bold Street, Liverpool, "Pumps and Pumping," C. N. Hillier, 7.15 p.m.

*Mon., May 26th.*—West and East Yorks Branch: The University, Leeds, "Plant Re-organisation," A. G. Dewhirst, 7.30 p.m.

*Thurs., May 29th.*—South Yorkshire Branch: Grand Hotel, Sheffield, "Foundry Mechanisation," P. McA. Martin, 7.30 p.m.

*Fri., May 30th.*—Birmingham Branch: Imperial Hotel, Temple Street, Birmingham, "Refrigeration," A. C. Curgenven, 7.30 p.m.

### Institute of Industrial Administration

*Wed., May 21st.*—Fyvie Hall, The Polytechnic, Regent Street, London, W.1, "The Human Factor—The Vitality of Management." "The Human Aspects," W. B. D. Brown, 6.30 p.m.

### Institute of Industrial Supervisors

*Thurs., May 22nd.*—London Central Section: The Polytechnic, Regent Street, London, W.1, Industrial Film Show and Discussion: Colour Film "Arc Welding" and "Hard Metal," 7.30 p.m.

### Institute of Navigation

*To-day, May 16th.*—Royal Geographical Society, 1, Kensington Gore, London, S.W.7, "Radar Chart-Matching Devices," J. Home Dixon, 5 p.m.

### Institution of Civil Engineers

*Tues., May 20th.*—Great George Street, Westminster, London, S.W.1, James Forrest Lecture, "The Progress of the Science of Soil Mechanics during the Past Decade," H. J. B. Harding, 5.30 p.m.

### Institution of Electrical Engineers

*Tues., May 20th.*—Education Discussion Circle: Savoy Place, London, W.C.2, Discussion on "The Teaching of Engineering Economics," opened by R. O. Kapp, 6 p.m.

*Wed., May 21st.*—Supply Section: Savoy Place, London, W.C.2, Discussion on "275kV Developments on the British Grid System," opened by D. P. Sayers, F. J. Lane and J. S. Forrest, 5.30 p.m.

*Fri., May 23rd.*—Utilisation Section: Savoy Place, London, W.C.2, "The Use of Electricity in a Modern Iron and Steel Works," W. F. Cartwright, 5.30 p.m.

*Tues., May 27th.*—Scottish Centre: Institution of Engineers and Shipbuilders, 39, Elmbank Crescent, Glasgow, Annual General Meeting, 7 p.m.

### Institution of Mechanical Engineers

*Sat., May 24th.*—Southern Branch, Graduates' Section: Visit to Poole Power Station, 2.30 p.m.

### Institution of Sanitary Engineers

*To-day, May 16th.*—County Hall, St. Helen's Street, Ipswich, Address by the President, S. Brassey-Edwards, Discussion on "Free Water Connections," and "Cathodic Protection of Water Mains," opened by John W. Good, 11 a.m.; afternoon visit to the works of B.X. Plastics, Ltd.

### Iron and Steel Institute

*Mon. to Wed., May 19th to 21st.*—Iron and Steel Engineers Group: Ashorne Hill, Leamington Spa, Meeting of Junior Engineers.

### Royal Society of Arts

*Wed., May 21st.*—John Adam Street, Adelphi, London, W.C.2, "Industrial Accidents," H. R. Payne, 2.30 p.m.

### Royal Institution of Great Britain

*Fri., May 23rd.*—21, Albemarle Street, London, W.1, "Continuous Creation," Sir Harold Spencer Jones, 9 p.m.

### Society of Instrument Technology

*Tues., May 27th.*—Royal Society of Tropical Medicine and Hygiene, Manson House, Portland Place, London, W.1, Annual General Meeting, "Recent Advances in the Industrial Use of the Microscope," E. W. Taylor, 6.30 p.m.

### Stephenson Locomotive Society

*To-day to Sun., May 16th to 18th.*—Week-end tour of N.E.R. lines and Motive Power Depots, also industrial railway visits, from Newcastle to Selby and Hull.

### Women's Engineering Society

*To-day and Sat., May 16th and 17th.*—35, Grosvenor Place, London, S.W.1, "Opportunity and Progress—Pictorial Review," 6.30 p.m.

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**Rutherford Scholarship.**—The council of the Royal Society has appointed Mr. E. M. Gunnersen, a graduate of Melbourne University, as the first Rutherford Scholar for three years, from October 1st next, to carry out work in nuclear physics at a university in the United Kingdom.

## British Standards Institution

*All British Standard Specifications can be obtained from the Sales Department of the Institution at 24, Victoria Street, London, S.W.1.*

### TUBULAR STEEL COLUMNS FOR STREET LIGHTING

No. 1840 : 1952. This is one of a series of standards for columns for street lighting, the others being B.S. 1249 for cast iron columns, a revised edition of which was issued in 1951, and B.S. 1308 for reinforced concrete columns.

The specification gives the standard heights of the light source, namely, 30ft, 25ft, 15ft and 13ft. It specifies details of construction and the loading for which the columns are to be designed. An appendix gives the design of and notes on a series of typical columns. Price 3s. post free.

### USE OF FINE-MESH TEST SIEVES

No. 1796 : 1952. Sieving tests are used in many industries for the routine control of the quality of materials, for research on their properties and for specifications concerning their marketing. Uniformity of procedure for the sieving tests is highly desirable to facilitate comparisons between tests made in different laboratories. B.S. 410, "Test Sieves" limits the tolerances of sieving cloth for test sieves as closely as manufacturing conditions permit, but there is need for guidance to operators in the method of using the test sieves. The need for such instruction has been realised for some time by those concerned in test sieving operations, and this was confirmed by the replies to a questionnaire issued by the Committee, in which widely differing procedures were quoted. No single method of sieving analysis can be specified to cover the many different materials concerned. Some materials are difficult to sieve and require specially developed techniques; it is, however, possible to formulate general principles of sieving which may be applied to many natural and artificial materials. In framing methods of procedure consideration must also be given to the object of the test, i.e., whether for routine control of manufacture or for a comprehensive programme of research on the properties of the material. Certain industries especially concerned with the sieving analysis of powdered materials have formulated specifications for the sieving procedure and they are incorporated in the appropriate British Standards. The recommended methods given in B.S. 1796 are not in any way intended to supersede such specifications, but are to serve as a general guide to sieve users.

This standard gives information on the principles of sieving as well as on the equipment to be used. It then proceeds to define the method by which the sample should be prepared for the test and the weight of sample to be taken. The sections that follow deal with the removal of fine dust by both the dry and wet methods. The actual sieving procedures are subdivided into those dealing with hand-sieving to the "end point" by the rate test, machine-sieving to the "end point" by the rate test and a routine sieving test. Other sections deal with such subjects as loss of dust during sieving, sieving tests on materials with only a small weight of oversize on the sieve, and the method of reporting results and accuracy of results. Finally, appendices are included dealing with methods of subdividing bulk samples which have been abstracted from B.S. 735, "Sampling and Analysis of Coal and Coke for Performance and Efficiency Tests on Industrial Plant", and some additional notes on procedure. Price 3s. 6d., post free.

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## Contracts

**The Crawley Development Corporation** has recently awarded the following civil engineering contracts, work on which has now commenced:—(*a*) Site development and ancillary works for the Langley Green neighbourhood and improvement works to the Polesfleet Stream, George Wimpey and Co., Ltd., in the sum of £672,368 12s. 10d.; (*b*) Crawter's Brook Improvement, industrial area section, open channel, concrete box culverts and flood storage pond, Willment Brothers, Ltd., in the sum of £116,532 9s. 5d.

**The English Electric Company** has received an order from the U.S. Department of Interior's Bureau of Reclamation for a fourth large transformer for the Folsom power plant switchyard on the Central Valley Project in California. It is an 80MVA auto-transformer and will be the first non-American equipment to go into the big hydro-electric project. The dam and power plant on the American river near Sacramento will, when completed, provide more than 160MW of hydro-electric power capacity.